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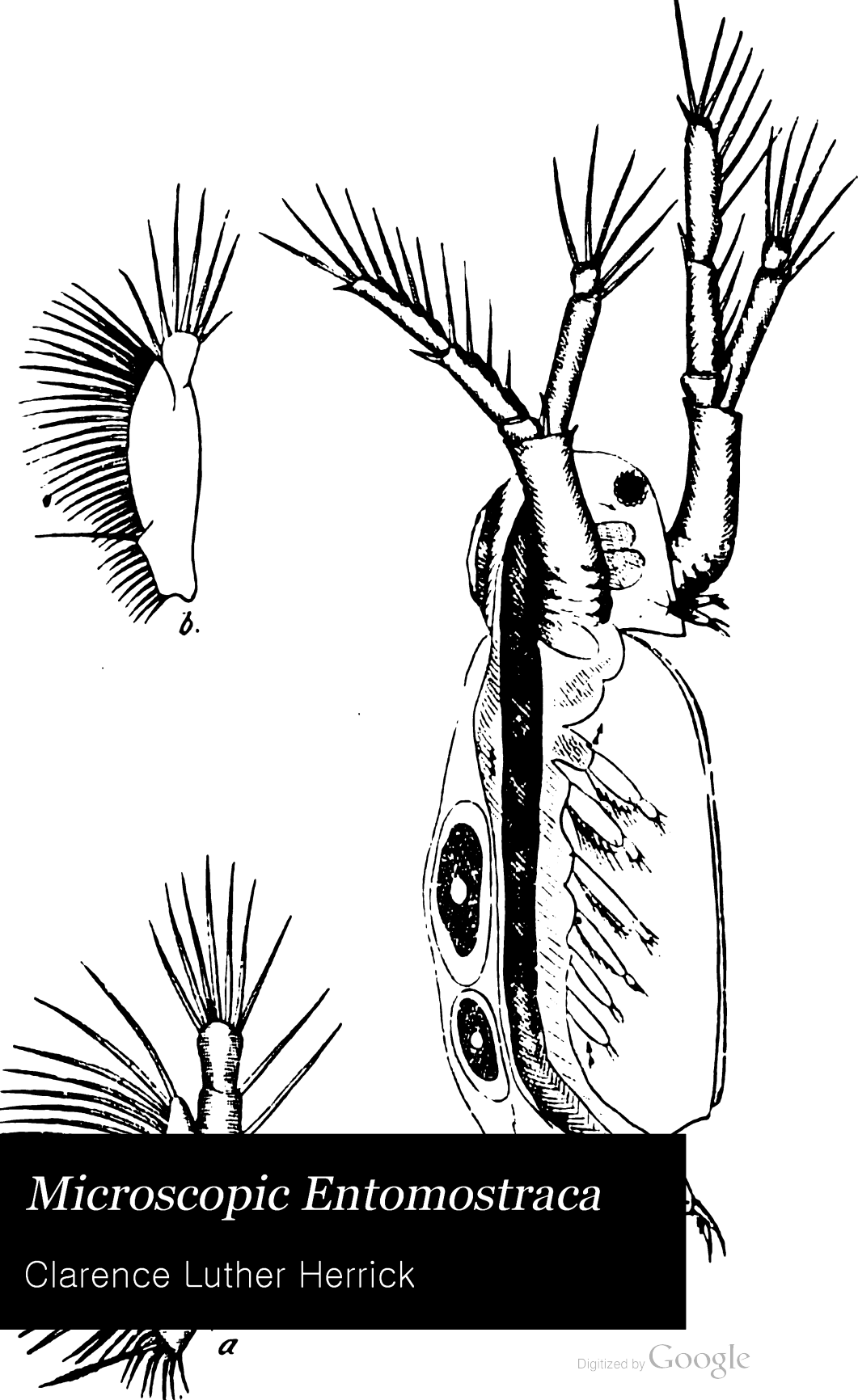

Microscopic Entomostraca

Clarence Luther Herrick

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APPENDIX B.

MICROSCOPIC ENTOMOSTRACA,

BY C. L. HERRICK, *Laboratory Assistant.*

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NEW HAVEN, JANUARY 8, 1879.

Prof. N. H. Winchell:

DEAR SIR: I have examined the chapter by Mr. Herrick, which you placed in my hands, and think it a valuable contribution to science. It will make a very appropriate addition, it appears to me, to the Minnesota State Report, because of its illustrating with well-drawn figures and good descriptions the life of the fresh water of the State. The species are among the most interesting of the minuter animals of the waters, and have a wide distribution over the globe.

Yours truly,

JAMES D. DANA.

MINNEAPOLIS, MINN., JANUARY 14, 1879.

Gen. H. H. Sibley, President of the Board of Regents:

I herewith communicate to the Regents an illustrated memoir on the microscopic crustaceans of fresh waters of Minnesota, as a contribution on the Natural History of the State, in accordance with law. This valuable paper, by Mr. C. L. Herrick, my laboratory assistant, has cost the Survey nothing more than the use of its rooms and apparatus, and has been submitted to the approval of Prof. J. D. Dana of New Haven, who indorses it as a valuable contribution to science, and recommends its publication.

Very respectfully,

N. H. WINCHELL.

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PREFACE.

It is with the hope that the following paper may be of service to some who, like myself, were interested in the many and varied forms found in every stagnant pool as well as in the lakes and ponds of our country, but who were unable to find any connected account of them, that it is offered to such, as a contribution toward a better understanding of a little known order of the natural kingdoms.

The lakes within a radius of ten miles of Minneapolis have furnished all the material examined, and the supply is not exhausted by any means. It is only hoped to so outline the extent and limits of this division of animal life that it will be less difficult to place the forms found from time to time, in approximately their true position.

With very few exceptions, as far as has been ascertained, no one has devoted any attention to the fresh water *Entomostraca* of America, and it is necessary for some one to act as a pioneer, to learn whether any of the forms described in Europe appear here, and to discover, if possible, if there be a general similarity between these widely separated faunæ. This has been the ambition of the present writer; and if only an intelligent attention be directed to this field, he will feel abundantly repaid for the attempt.

The works consulted were Dana's "Report of the Crustaceans collected during the Wilkes Exploring Expedition to the Pacific Ocean", Dr. W. Baird's "British Entomostraca," "Report of U. S. Fish Commission," papers in "Hayden's Survey of the Territories", and papers in the American Naturalist and other periodicals. Many thanks are due to Prof. N. H. Winchell, director of the State Geological Survey, for assistance and advice in many ways; to President W. W. Folwell, and Dr. P. L. Hatch, for assistance and intelligent sympathy, and to fellow members of the "Naturalist's Club."

That there will be found mistakes in the work is to be expected, but it is hoped that the information will be reliable in the main.

It is not without hesitation that, as a novice in scientific investigation, names are suggested for the new species found, but the purpose of this paper will be best served by defining as well as possible these forms, and submitting them to the test of further study; and if in the future more experience and greater research can be brought to bear upon this domain, these preliminary notes will perhaps not be without their value. The drawings were all made by the writer, in most cases from life, though some details have been introduced from the works consulted, and the plate of *Phyllopoda* was collected from the government reports and elsewhere. Clearness in outline and detail rather than beauty in execution was the desideratum.

C. L. HERRICK.

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INTRODUCTION.

ENTOMOSTRACA.

The name was derived from two Greek words meaning insect and shell, by Otho F. Muller, and applied by him in his "*Entomostraca*" (1785) to the animals which had hitherto been all comprised in Linnæus' genus *Monoculus*, named from the supposition that they all possessed but one eye. The name "*Branchipodes*" was also proposed, and would have been appropriate enough, but Muller supposed that the branchial appendages which suggested the name, were wanting in *Cythere*, etc. Muller, aside from naming the group, was the first to arrange these animals in anything like a systematic classification, and collected a great deal of interesting information. Since his time several authors have written upon these interesting animals in Europe, but with a few exceptions no systematic work on Entomostraca has appeared in English.

Dr. W. Baird published in 1850 a superb work on the Entomostraca of Great Britain. which is still the best thing in the English language. But since this work was published, many additions have been made to our knowledge. In Prof. J. D. Dana's magnificent work on the Crustacea found in the "Wilkes Exploring Expedition", many new species are described, and a revised classification for the whole order is proposed. In this work every known genus was characterized. Since then additions of new species have been published by various authors, and are scattered through the reports of various societies. Moreover, recent studies in Embryology have thrown new light on the classification of all the lower animals, and many changes are necessary, but it is not possible at this stage of the study to attempt a

SYSTEMATIC ARRANGEMENT

of this order. We shall follow quite closely Dana's system as being most complete.

The following changes, which will not affect essentially the nomenclature used must be indicated as the necessary result of modern research:

1, The *Merostomata*, or King Crab group, which contains the modern genus *Limulus* (Horseshoe Crab) and the ancient *Eurypterida*, etc., which was considered by Dana a sub-order of Entomostraca has by recent writers been regarded as a distinct order intermediate between the *Trilobita* (which Dana included with the sub-classes *Chorostopoda* and *Entromostraca* in the class *Edriophthalmia* or *Tetradecapoda*) and the *Entomostraca*.

Trilobita now stands at the foot of the sub-kingdom, its inferiority in rank being assumed from the inferiority in point of time.

The *Cormostomata* (including *Pœcilopoda* or *Epizoa*) has been united with *Copepoda (Cyclopacea)* thus doing away with the sub-orders in Entomostraca.

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The *Pectostraca* (including *Rhizocephala* and cirripeda (barnacles) have been assigned a place among the Entomostraca from facts learned regarding their development. These crustaceans have been tossed from one division to another till they ought, it would seem, to find a permanent resting place. First considered mollusks, they have now taken their position among the lower crustaceans. These creatures, which are at maturity firmly cemented to foreign bodies, and are inclosed in a hard shell-like test have, in their earlier stages, forms resembling the "Nauplis" stage of *Cylops* (see plate III.) and also a stage resembling the mature *Cypris*.

It is now known that, as Huxley expresses it, "the barnacle is a crustacean fixed by its head and kicking its food into its mouth." The attachment of the head finds a parallel in the genus *Sida* (see beyond), which contains animals that can attach themselves at will to bodies by a sucker-like disk on the head, corresponding to the pedicle of the barnacles. As the barnacles and epizoa have not been observed no further mention will be made of them in this connection.

The following table from Huxley's Anatomy of Invertebrates will perhaps be useful for reference.

(Articulates or)

ARTHROPODA.

I.

Without manducatory appendages *(Gnathites)*

Trilobata. Tardigrada (?) Pentastomida(?)

II.

With pediform gnathites.

Merostomata. Arachnida. Peripatidea.

III.

With maxilliform gnathites.

Entomostraca.	Myriapoda.
Malacostraca.	Insecta.
Water-breathers.	Air-breathers.

For the most part.

The extent of the *Entomostraca* has been outlined above, and the *Malacostraca* includes the remainder of the crustaceans, viz: those included by Dana under *Podophthalmia* and the order *Choristopoda* of *Edriophthalmia*, thus embracing crabs, shrimps and all the higher crustaceans, whose body consists (almost always) of twenty segments (somnites) of which six constitute the head, and bear, respectively, the eyes, superior antennæ, inferior antennæ, mandibles, and two pair of maxillæ. Of the remaining somnites eight pertain to the thorax, and carry the foot jaws and walking limbs, while six are abdominal and bear swimming limbs. These higher forms do not go through the Nauplius stage in their development, as do the *Entomostraca*.

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GENERA CHARACTERS OF ENTOMOSTRACA.

The Crustaceans of this order are quite various in form, habits and internal structure. They possess specialized jaws, but there are never more than three pairs of qualities, while in the higher orders there are often six.

The somites of the abdomen (that portion of the body posterior to the genital aperture) are devoid of appendages. Though the study of these animals is very fascinating and instructive the task is a difficult one, both on account of the minute size of most of them and the great difficulty of ascertaining with what organs of the higher forms some of the novel instruments seen are homologous. The curious misapprehensions and inaccuracies into which authors have fallen still further complicates the matter.

The descriptions of these organs, and their functions, must be taken up under the divisions of the order and treated separately. The process of reproduction is particularly interesting in this group, for we have numerous instances of agamogenesis and the *Pectostraca* are hermaphrodites peculiarly modified Alternate generation will be spoken of more particularly under the *Daphnioidea*. The species described have all been collected and compared with descriptions of previous authors, the new species, it is hoped, will be found sufficiently well defined in connection with the figures given to permit of a ready identification.

The following table of the families of the order will be useful for reference, while the characters upon which they are founded, and synonyms, will be found in their appropriate places.

TABULAR VIEW OF ENTOMOSTRACA.

ORDER ENTOMOSTRACA.

LEGION I. LOPHYROPODA.

TRIBE I. CYCLOPOIDEA (here used as equal to *Copepoda* with the *Pœcilopoda* among he *Cormostomata* (or *Epizoa*.)

Family 1. Calanidæ.
Family 2. Cyclopidæ.
Family 3. Corycaidæ.
Epizoa?

TRIBE II. DAPHNIOIDÆ. (Cladocera.)

Family 1. Penilidæ.
Family 2. Daphnidæ.
Family 3. Bosminidæ.
Family 4. Polyphemidæ.

TRIBE III. CYPRIDÆ.

Family 1. Cypridæ.
Sub-family a. Cyprinæ. (Cypridæ Bd.)
Sub-family b. Cythrinæ. (Cythridæ Bd.)
Family 2. Halocypridæ.
Sub-family a. Cypridininæ. (Cypridinadæ Bd.)
Sub-family b. Halocyprinæ.

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LEGION II. PHYLLOPODA.

TRIBE I. ARTEMIOIDEA.

Family 1. Artemiadæ. (Branchipodidæ.)
Family 2. Nebaliodæ.

TRIBE II. APODIDÆ.

Family 1. Apodidæ.

TRIBE III. LIMNADIOIDÆ.

Family 1. Limnadidæ.

Note—Other genera have been added to those given by Dana, and changes made. The family Estheriadæ seems, however, to be equivalent to Limnadidæ.

LEGION I. LOPHYROPODA.

Bibliography.—Lophyropa, *Latreille*, Cuv. Regne An., 1677;
Lophyropoda (in part), *Leach*, Dict. Sci. Nat., XIV., 554.
———— ———— *Gray*, Cat. Brit. Crust. Brit. Mus., 1850, 100.
———— ———— Baird Brit, Entomost., 138.
Cranchiopodes franges (in part), *Lamark*, Hist. Ans. Vert.

Characters.—Feet normal and not greatly multiplied in number.

TRIBE I. CYCLOPOIDEA.

Bibliography.—Carcinoida (in part), *Latreille*.
Copepodes, *Edwards*, Crust., iii., 411.
Copepoda, *Baird*, Trans. Berw. Club, ii., 1875.
———— Baird, Brit. Entomost., 182.
Cophyropoda, *Burmeister*, Organiz. of Trilobites.
Copepodita, *Gray*, Cat. Brit. Crust. Brit. Mus., 1850.
Crustacea copepoda (Cyclopacea), *Dana*, Proc. Ardes. Acad. Sci. and Art., 1847.
Cyclopoidea, *Dana*, Rep. Wilkes' Exp. Ex., p. 1020.

Characters.—Body elongate, straight, never incurved. Cephalothorax and abdomen with few joints. Feet and jaws 16 to 18. The 6–10 posterior thoracic feet are double, foliaceous, with the last often prehensile.

This is a very extensive and widely distributed division, and there is a greater unity of plan seen in the structure of the animals comprised in it than in other divisions of similar importance. These creatures are distributed over the world, in both fresh and salt water, and the numbers may doubtless be reckoned by thousands, but little attention has been devoted to the subject, and our knowledge is quite meagre.

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The Cyclopoidea are considered the highest group in the order, approaching the Macroural Crustaceans. The body is not covered by a carapace, as in the following tribes, and the abdomen is extended in the same line as the body, and not incurved as in Daphnioidea, etc. The abdomen is terminated by two stylets which bear several setæ. If the Epizoa are to be admitted into this tribe, certain modifications would be necessary, which we need not discuss.

The cephalothorax is composed of from four to seven segments. In those species having four segments, the first bears the first and second antennæ, mandibles, maxillæ, maxillipods, first feet and one pair of natatorial feet, while the following three carry the remaining pairs of natatores.

Eyes of the three kinds: 1. A pair of simple internal eyes with spherical lenses, which are the ordinary kind. These are usually united near the front in a single very small spot, though they are sometimes remote.

2. A pair in an elevation on the under side of the head between the antennæ. The pigment is often like a piece of solid indigo.

3. A pair of simple eyes consisting of an internal prolate lens situated at the extremity of a vermiform mass of pigment and of a large oblate, lens-shaped cornea. This kind of eye is found in the Corycæidæ.

Antennæ. The antennæ are of two pairs, of which the superior are organs of locomotion, and usually are long and powerful. In the males of many species one or both are modified to form a joint by which the female is held during coition. These modifications are often of generic importance.

The secondary antennæ are subjected to greater changes and serve various functions. Sometimes they are simple; in other species they have two rami. They are often prehensile, and when simple the setæ at the end are movable so that they assist the animal to creep on surfaces.

The mouth is situated in the posterior aspect of a low prominence beneath the head.

The mandibles are variously modified.

The maxillæ are one to four jointed organs.

The maxillipeds are always simple, or if divided the branch is rudimentary.

Anterior pair of legs (or *second maxillipeds*). These organs vary greatly in form, and afford means of generic classification, and will be described under their appropriate heads.

Natatory feet. These are similar to those of other Entomostraca, bearing setæ for locomotion. There are four pairs, and sometimes a prehensile or abortive pair following.

The heart is situated in the posterior part of the thorax, and the circulation may be watched as the blood globules circulate between the tissues; particularly in some transparent species of Calanidæ these may be well traced in the thorax.

Nervous system. A large ganglion exists over the mouth, and surrounds the œsophagus.

This tribe includes three families, as given by Dana, but the Epizoa must probably be included also. The family *Corycæidæ* is oceanic, and no members have been found in our locality.

FAMILY I. Calanidæ.

Bibliography.—*Dana*, Wilkes' Explor. Ex,. p. 1039.

Characters.—Eyes often of two kinds, the upper pair being simple and minute, with their pigments either separate or collected into one. In

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some species there is another pair beneath, with joined pigments. Mandibles and maxillæ elongate, carrying a palpus, which is furnished with setæ. Ova sac one. First pair of antennæ long, unappendaged; the right or neither having a geniculating joint. Feet of the first pair never sub-prehensile at the end.

The Calanidæ are divided into three sub-families, only one of which has been found to be represented in our locality, however, the classification will be indicated.

SUB-FAMILY 1. CALANINÆ.—Abdomen of moderate length, inferior pair of eyes wanting. Right superior antennæ of male without a geniculating joint. Secondary antennæ setigerous at the end.

Genus 1. Calanus, *Leach*, *Dana*.
Genus 2. Rhincalanus, *Dana*.
Genus 3. Cetochilus, *Goodsir*.
Genus 4. Euchæta, *Philippi*.
Genus 5. Undina, *Dana*.

SUB-FAMILY 2. OITHONINÆ.—Abdomen linear produced, scarcely shorter than the cephalothorax. Inferior eyes wanting. Maxille digitate on the interior margin. Superior antennæ long, few-jointed; right male antenna not geniculate nor movable in an angle.

SUB-FAMILY 3. PONTELLINÆ.—Abdomen of moderate length. Eyes sometimes of two kinds. Antennæ long and, in all the genera but *Acartia*, having a geniculating joint. Second antennæ setæ-bearing at the end. Posterior feet of the male thick; the right prehensile.

Genus 1. Diaptomus, *Westwood*.
Genus 2. Hemicalanus, *Dana*.
Genus 3. Candace, *Dana*.
Genus 4. Acartia, *Dana*.
Genus 5. Pontella, (*Pontia*, *Edwards*).
Genus 6. Catopia. *Dana*,

Genus Diaptomus, Westwood.

Bibliography.—Monoculus, *Linnæus*, *Fabricius Jurine*, etc.
Cyclops, Muller, *Desmarest*, *Manuel*, etc.
Diaptomus, *J. O. Westwood*, Partington's Cycl. Nat. Hist., Entomologist's Text-book, 1838.
———— *W. Baird*, Brit. Entomost., p. 219.
———— *J. D. Dana*, Rep. Wilkes' Expl. Ex., p. 1045.
Cyclopsina, *M. Edwards*, 1840.
———— *Philippi*, 1843.
———— *Baird*, Zoologist, i. 56: Trans. Berw. Clarb.
———— *Dana*, Proc. Amer. Acad. Art and Sci.
Omethina, *Templeton*, Trans. Ent. Soc., ii., 118, 1838.
Broteas, *Loven*, Kongl. ret. Akad. Handl., 1845, p. 436.

Characters.—The smaller ramus of the secondary antennæ six to seven jointed. Maxillipeds scarcely less, often larger than the first pair of feet. Posterior pair of feet in the male thick, the right prehensile, those of the female long and different from the preceding pairs. Ova sac one.

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Of the two species here described, one is certainly a member of this genus, while the other is in many respects more like Dana's genus *Hemicalanus*, which differs from *Diaptomus* in not having the posterior feet of the female large and stout and the shorter branch of the secondary antennæ without the numerous joints. The species of *Hemicalanus* are also oceanic. and none were seen to have ova sacs. Both our species have single ova sacs, while one is not evidently furnished with the plurality of articulations to second antennæ. Not having given a full account of the family, it may be well to incorporate a more general with the technical description. These animals are usually small, seldom reaching one-fourth of an inch, but commonly appearing as mere specks in the water. The body is canoe-shaped, and divided into two portions. The main portion, or cephalothorax, is usually much the longest. The antennæ are the organs of locomotion, being used as oars in the same manner as the "water-boatman," etc., use the feet. The posterior pair of feet vary with the sexes, as described above, the four following pairs are swimming organs, while the anterior pair are modified and turned forward.

The cephalothorax is more often seven jointed in *Pontellinæ* than in the *Calaninæ* but this is not a constant character.

Diaptomus longicornis, Herrick.*

This speccies is very near to *D. castor* and may, indeed, be a variety of that species, it differs, however, in shape and color from figures of that species, and the maxillæ, and antennæ differ considerably. Cephalothorax rather long, narrowly oval, six-jointed; superior antennæ, rather long but they are not curved as represented in Dr. Baird's figures of *D. castor*. The male right antenna has a geniculating joint at the thirteenth segment which is armed with a considerable curved spine; the joints following are more or less enlarged and sometimes coalesce, forming in extreme cases a monstrosity as represented in Geol. and Nat. Hist. Rep. for 1876. The secondary antennæ are two branched, the outer ramus being three-jointed and armed at the extremity with three curved spines, forming a sort of hand, the middle segment also bears a number of setæ on the inner margin, the minor ramus is six or seven-jointed, though it appears three-jointed at first, the middle segment being sub-divided. The head is produced into a beak in front but it is much smaller than in the following.

The maxillepedes (or first pair of feet) are of three portions, the latter two bearing setæ which are directed towards the head, the final division is composed of about six small joints each bearing a tuft of the sete. The remaining pairs of feet are alike, each having two setigiferous rami. In the female the fifth pair of feet are prehensile and stout, those of the male are unlike, the right being long and the other rudimentary.

This species is very brilliantly colored, the tips of the antennæ and last segments of the abdomen are a fine bluish purple, while the body is variegated with red, yellow and purple. The mass of eggs is also a beautiful red. Only one locality is known to contain the creature, though it may be abundant in the more marshy pools. In the Rep. of the Geol. Surv. of Minn. for 1878 it was mentioned and a figure given, but erroneously called cyclops. (See plate I.)

*See D. sanguineus, *Forbes* in Ill. State Mus. Rep. 1876. The description differs, apparently, in several respects, notably as to color, but the species is certainly closely allied.

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Diaptomus pallidus, Herrick.

A more abundant form than the above, though less striking in appearance, is the creature for which this name is suggested. The cephalothorax is more elongate and has but five segments. The antennæ are much longer, considerably exceeding the body in some specimens. The joints of the antennæ following the geniculating joint are not united or modified, neither is there an appendage to the segment immediately preceding. The whole body is slender and graceful, resembling *Hemicalanus* but the fifth pair of feet is not obsolescent. The secondary antennæ were not noticed to have the multiplied intermediate oints in the minor ramus, but such may be the case.

This animal abounds in the larger lakes, and seems to prefer pure water, while the other is found in more stagnan twater. These creatures are not found infested by bell animalcules and desmids as is the cyclops, probably from their rapid motions and the nature of their haunts.

D. pallidus may be at once distinguished from *longicornis* by its lacking the brilliant coloring of the other, it being quite colorless, and by its smaller size.

D. longicornis is 65-1000 inch in length, while the species in question rarely exceeds 40-1000 inch. The eye in this species is also less conspicuous. (See plate II.)

FAMILY II. **Cyclopidæ.**

Bibliography.—*Dana*, Rep. Wilkes' Exp. Ex., Vol. XIV. Part 2, p. 1039.

Characters.—Eyes small, simple, usually with united pigments. Mandibles with a small or obsolete palpus and few setæ. Ova sacs one or two. Primary antennæ, often appendaged. Both or neither of the male antennæ geniculate. Feet of the first pair more or less prehensile at the end.

The prehensile character of the first pair of legs is chosen by Dana as the chief characteristic of the family; these organs sometimes being perfectly prehensile, with a perfect monodactyle hand, which never occurs in Calanidæ. These animals often possess appendages to the first and second segments of the abdomen, as see plate of *Canthocamptus.*

The cephalothorax has little variation in structure, having either four or five segments. The anterior antennæ are more often much shorter than the body, and if either of them is modified in the male, both of them have a geniculating point. The abdomen is five or six jointed, and may or not be abruptly smaller than the cephalothorax, which fact forms a basis for generic distinction.

The genus Cyclops possesses two ova sacs, while the remaining genera, so far as known, have but one. This leads to the division of the family into the two leading sub-families. The third sub-family is founded by Dana upon some sapphirina-like species of doubtful affinities, described by H. D. S. Goodsir.

Sub-family 1 Cyclopinæ, Dana.

Characters.—Ova sacs two.

Genus 1. Cyclops, *Muller.*

? Genus 2. Cyclopina, *Claus*[*]

*There are a considerable number of genera of the following sub-families, etc., mentioned in Claus' "Zoologie", which are, for the most part, not described. Since I have not been able to consult the works in which they are defined, and since he seems not to recognize many of those described by Dana, and to disregard his classification, the deciphering of their relation and situation will not be attempted here.

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? Genus 3. Psammathi, *Philippi*, Archiv. fur Naturgeschicte.
? Genus 4. Idomene, *Philippi*, " " "
? Genus 5. Euryte, *Philippi*, " " "

GENUS 1. Cyclops.

Bibliography.—(See Cyclops quadricornis.)

Characters.—Cephalothorax four-jointed. Anterior antennæ of the female not appendaged; of the male both geniculate. Appendage at the base of abdomen small. Body sub-cylindrical. Feet of the first pair didactyle.

The various species of this genus are found in inland waters the world over, being essentially fresh water animals, in a few cases only inhabiting water a little brackish. They are among the most abundant of all the individuals of the order, every standing pool abounding in them; they are also extremely variable both in different stages of the same animal, in the different sexes and in different localities.

The young stages of Cyclops have been named as distinct species, in so far that the same animal has been honored with three or four different titles between birth and maturity. In our own locality many forms have been found, and it is quite likely that careful study would enable us to distinguish several species and numerous varieties, but such is the extreme variability of the one known to exist here, that it is not now possible to draw a dividing line between the varying forms, so that all that is attempted is to give a general view of the species, and leave further definition for more minute investigation.

Cyclops quadricornis, Muller.

Bibliography.—Monoculus quadricornis, *Linnæus*, *Gmelin*, *Scopoli*, *Fabricius*, *Jurine*, *Sulzer*, *Donovan*, *Blumenbach*, *Manuel*, *Barbut*, *Shaw*.
Monoculus apus, *Poda*.
Le Monocle à querie fourchue. *Geoffroy*.
Le Monocle à quatre cornes. *De Geer*.
Cyclops quadricornis, *Muller*, Zool. Dan. Prod., 2416, 1776.
———— *Ramdhor*, *Latreille*, *Box*, *Lamarck*, *Baird*, *Leach*, *Koch*.
———— *Baird*, Brit. Entomost, p. 198.
Cyclops Geoffroyi, *Lamouelle*, British Insects, 81.
Cyclops vulgaris, *Desmarest*, *M. Edwards*, *Leach*.
———— *Baird*, Trans. Berw. Club, i., 97, (young).
———— *Garner*, Nat. Hist., Staffordshire.
Pediculus aquaticus, *Baker*, Empl. for Micros., 383.
Satyr, *Baker*.
Nauplius saltatorius, *Muller*, Zool. Prod., No. 2378.
Four-horned Cyclops, *Prichard*, Microscop. Cab.
Cyclops quadricornis of most recent writers.

The full grown female is often of considerable size, attaining the length of .09 in. or more. The male is smaller, and there is every possible gradation between the above and small forms scarcely perceptible to the unassisted eye.

The cephalothorax is usually regularly oval, but varies from short oval to oblong, it is composed of four segments, of which the anterior one is largest,

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equaling or exceeding the remaining three. The superior antennæ vary in length and form. Their shape is that of a letter s. In the male both antennæ possess the hinge, or geniculating joint, which serves as a hand for retaining the female during copulation. The antennæ are about twenty-six jointed, and furnished with numerous setæ. The secondary antennæ are four-jointed, and have six setæ at the end, serving as organs of prehension.

The mandibles are ovoid bodies, terminating in short teeth, and carrying a sort of palpus of two filaments.

The maxillipeds are somewhat similar but are furnished with two toothed processes.

The first pair of feet are organs of prehension, having two rami, of which the smaller, a three-jointed organ, springs from the base of the outer or main branch.

The basal joint of the outer ramus besides bearing the other has two projections on the inner side, the second joint is hook-shaped, as is the final and smallest segment which springs from it. The four following pairs of feet are composed of two rami, each consisting of three setæ-bearing joints, as see plate of Cyclops. There is also a pair of appendages at the base of the first segment of the abdomen. The abdomen is six-jointed, the final joint somewhat bifid, each side terminating in a caudal stylet between which is located the anus.

These stylets give rise to two small setæ on the outer margin and four at the extremity. The inner pair of filaments are usually much the longest, and are also different from the others in having a joint near the base which gives greater freedom to their motions. The setæ are usually barbed backward, and in old individuals are most beautifully pectinate. In cases where the moulting has been arrested these and the other hairs attain a curiously long growth, as illustrated in the plate, and the barblets become filiform appendages.

The digestive canal begins near the front of the thorax and can be traced to the anus. The ovaries are two, and are easily seen in the body, and communicate with external ova sacs. After the eggs are extruded from the ovary into the pouches they are not dependent on the mother, but will come to maturity if separated from her. These eggs vary in number, old individuals laying upwards of forty. It is calculated that in one year a single female would have become the projenitor of 4,442,189,120 young so that the abundance in which they occur, notwithstanding the ravages of the Hydræ, and other enemies, is not strange. A single copulation fertilizes the female for life, as in the case of the Aphides. The eggs, as they are hatched, descend from the ovary covered by a transparent pellicle in which they remain from two to ten days. The growth of the young is illustrated in the plate, the operation occupying about twenty or thirty days. The cyclops moults a number to times during its life, and as the power of replacing lost parts, they are also very tenacious of life, often reviving after being frozen for a long time in the mud and water, which form their hiding places.

The cyclops is probably both carnivorous and a vegetable feeder.

Plate III. represents the usual form, the figures showing the different stages are copied from Dr. Baird's Entomostraca. *Plate IV.* gives one of the varieties collected here which may be worthy of a specific name; the greatly exaggerated caudal filaments and general hairiness is, however, only an age-modification, the color of this variety is dark, while the eggs in the sacs are pellucid. Another variety is oblong in shape and lighter in color, while the egg sacs are opaque. Still other varieties are smaller, and vary from bright red to green in color, having the egg sacs diverging from the abdomen. There seem to be intermediate forms and it is best to await further study before separating these varieties. (See Plates III. and IV.)

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SUB-FAMILY 2. HARPACTICINÆ.

Characters.—External ovary only one.

* Cephalothorax 4-jointed.

Genus 1. Canthocamptus, *Westwood.*
Genus 2. Harpacticus, *Edwards.*
Genus 3. Westwoodia, *Dana.*
Genus 4. Alteutha, *Baird.*
Genus 5. Metis, *Philippi.*
Genus 6. Clytemnestra, *Dana.*
Genus 7. Setella, *Dana.*

** Cephalothorax 5-jointed.

Genus 8. Laophon, *Philippi.*
Genus 9. Oncæa, *Philippi.*
Genus 10. Ænippe, *Philippi.*
Genus 11. Idya, *Philippi.*

Genus 1. Canthocamptus.

Bibliography.—Monoculus, *Linnæus*, *Fabricius*, *Jurine*, etc.
Cyclops, *Muller*, *Ramdohr*, *Latreille*, etc.
Cyclopsina (part), *M. Edwards.*
Canthocamptus, *Westwood*, Partington's Cyclop. Nat. Hist. art. Cyclops; Entomologist's text-book, 115.
Canthocarpus, *Baird*, Trans. Berw. Nat. Club.
Harpacticus (part) *Dana*, Proc. Amer. Acad. Arts and Sci., 1847.
Nauphilius, *Philippi*, Ann. Mag. Nat. Hist., 1840; Wiegm. Archer, 1843.

Characters.—Body scarcely flattened, generally linear or narrow. Feet of the first pair (second jaw feet of Baird) more often small; those of the second pair with two rami, rami three jointed. Antennæ of the female with an appendage at the end of the fourth joint, those of the male both with a geniculating joint. Appendix to base of the abdomen small. Generally no sudden transition from the segments of the thorax to those of the abdomen.

Canthocamptus minutus. *Bd.*

Bibliography.—Cyclops minutus, *Muller*, Zool. Dan. Prod., No. 2409, 1776; Entomostraca, 101, t. 17, f. 1–7.
———— *Ramdohr*, Beyt, zur Naturg., 10–13, t. 3, f. 1–9.
———— *Latreille*, Hist. Nat. Crust., IV. 266.
———— *Bosc*, Mém. Hist. Nat. Crust., ii. 257.
———— *Lamarck*, Hist. Aus. Vert., V. 189.
———— *Baird*, Trans. Berw. Nat. Club, i. 97, 62, f. 1, 19, 20, etc.
Monoculus. *Gmelin*, Linn. Sgot. Nat. Edit. 13th, i. 2997, No. 11.
———— *Fabricius*, Ent. Syst., ii. 499, No. 45.
———— *Manuel*, Encyc. mith., vii., 719, t, 267.
Monoculus staphylinus, *Jurine*, Hist. Nat. Monoc., 74–84.
Cyclops —— *Desmarest*, Cons. Gen. Crust. 363, t. 53.
———— *Baird*, Trans. Berw. Nat. Club, i. 97.

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Small Cyclops or Vaulter, *Prichard*, Mec. Cab., t. 9, f. 7.
Amyone satyra and Baecha, *Muller*, Entomost., 42 t. 2 (young).
Der Satyr, *Kohlers*.
———— *Prichard*.
Cyclopsina staphylinus, *M. Edwards*, Hist. Nat. Crust., iii. 428.
Canthocarpus ——— *Baird*, Trans Bew. Club, ii., 154.
Nauphilius minutus, *Philippi*, Weigm. and Erichs, Ar. 1843, 69.
Doris minuta, *Koch*, Deutsch, Crust., li. XXXV. t. 3, 1841.

Variety occidentalis. Herrick.*

Description, etc.—This variety, which is the only member of the sub-family yet distinguished in our locality, is so closely related to the type of the species as described by Dr. Baird that it is with much hesitation that it was finally concluded to separate it. The description given will apply to both, with such exceptions as will be pointed out.

Body rather long with no obvious distinction between the segments of thorax and abdomen, composed of ten segments, which taper toward the tail. Cephalothorax acute in front, resembling that of species of *Calanus* (in which respect it differs from Dr. Baird's figures of the European species) forming a sort of beak below. Viewed from the side the shape is triangular. The primary antennæ are shorter than in Cyclops, and those of the males more altered than is usually the case in that genus. In the male they consist of seven joints, the fourth of which is much enlarged.

The antennæ of the female possess eight or nine joints. and have a small projecting appendage from the extremity of the fourth segment. The secondary antennæ are simple with two or three joints.

The eye is bright red and contrasts finely with the pale yellow of the body. The mandibles are similar to those of the cyclops. The maxillipeds are divided at the end into four divisions at the extremity of which spring three or four setæ.

The first pair of feet (or second foot-jaws of Baird) are small, three-jointed organs. The final joint is hook-like, and directed forward for the purpose of arresting food particles and carrying them to the mouth.

The second pair of feet are large and modified in form, differing from the natatorial feet, (they form the basis of classification in this whole sub-family). Each is composed of two three-jointed rami, of which the outer one has the joints nearly equal with three setæ. At the apex of the final one, the inner ramus has the upper joint long, almost equalling the outer ramus. The second joint is shorter and with the final one, which carries at the extremity three long setæ, is serrated on the anterior margin. This ramus is directed forward also. The three following pairs have the rami unequal but both with three joints.

The sexual openings are at the base of the sixth segment. In copulation the males seize the caudal stylets with the geniculating joint of the primary antennæ and are bourn about rapidly by the female.

In most of the females seen there was a organ attached to the vulva, it consists of a long flexible stalk terminated by a cylindrical or club-shaped mass, which may be dark brown, red or pellucid.

*S. A. Forbes describes a species in Report Ill. Mus. Nat. Hist., the characters of which I have not been able to compare with our specimens, but it seems distinct.

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It was conjectured by M. Siebold that these were similar to the seminal tubes discovered by him upon Diaptomus. The act of copulation in Diaptomus, as described by him, is so strange and improbable that it is hard to accept without some hesitation. He says that "the male does not accomplish a true coition but attaches to the female, during copulation, a tube containing spermatic liquor. This tube contains, beside the zoosperms, two substances of which one swells by the influence of water, and chases out the whole contents of the tube. The other substance coagulates, leaving in the middle of the mass a canal by which the zoosperms arrive at the vulva."

In the case of the Canthrocamptus, however, the appendage is apparently of a different nature, being corneous and harder than the rest of the animal, moreover in no case have more than one of these been observed on the same female. Jurine, however, says that this body is never seen till after she has several times laid eggs. Dr. Baird adds that he has never seen more than one on the same female, and that no mature female is met without it, even though the ova are attached. My own observations accord with the above, but I am unable to add any suggestion as to the use of these organs.

The females are larger and usually darker in color than the male.

Habitat.—Shallow lakes and pools; everywhere abundant.

This species will repay well patient study, and from its abundance is easily found. This western variety is distinguished from the eastern type by the shape of the head, the greater brevity of the caudal stylets. the shape of the ova sac, the greater size of the fourth joint of the male antennæ. and other minor differences, which no great stress is laid upon, however; and these variations may be due to inaccuracies of the drawings of Baird's book. (See plate V.)

Sub-family 3. Steropinæ, Dana.

Characters.—Form somewhat like Sapphirina, but the eyes minute, and generally situated in a prominence in the front. Superior antennæ short. Feet of the first pair monodactyl as in Corycæcidæ. Caudal stylets short, sub-cylindrical.

Genus 1. Zaus, *Goodsir.*

Genus 2. Sterope, *Goodsir.*

No member of the family was met with.

FAMILY III. CORYCÆIDÆ.

The species are all oceanic. A species of Sapphirina is figured in the Rep. of Fish and Fisheries for 1871 and 1872.

TRIBE II. DAPHNIOIDEA. Dana.

Bibliography.—Daphnioidea, *Dana*, Rep. Wilkes' Expl. Ex., p. 1262.
Cladocera, *Baird*, Brit. Entomost. p. 62, 1850.
———— *Burmeister*, But. zur Naberg. Der Rankenfuss.
Daphnides, *Straus*. Mem. Mus. d'Hist. Nat.
Daphnoides on Cladocères, *M. Edwards*, Hist. Nat. Brust., iii. 372.
———— *Lucas*, Exp. Sc. de l'Algine.

Characters.—This tribe which corresponds with the *order Cladocera* of Baird and some recent authors, is characterised as having the whole

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body, exclusive of the head, (which is covered with a separate and similar plate) included in a large carapace, which is open below and behind, permitting the protrusion of the posterior portion of the abdomen, and allowing currents of water to pass within, both for respiratory purposes and to carry to the mouth particles of food.

The carapace is composed of three parts, in one species at least, and it would seem that this is the typical structure. The middle plate (in Daphnia vetula) lies over the dorsal region; the other two spring from it, flanking it on either side, and forming the bulk of the shield. We would suggest the probable similarity of the central shield to the caudal shield of other crustaceans, and the possibility that the now larger portions ought really to be considered as accessory simply.

The Daphinoidea possess from four to six pairs of foliaceous appendages, or branchial feet which do not assist in locomotion. The eye is apparently single and is a very prominent organ in all the members of the tribe, it is large and furnished with numerous lenses.

The superior antennæ are small, often obsolete, and except in Bosmina only one or two-jointed. The inferior antennæ are large, being the true organs of locomotion, and several-jointed.

The abdomen is incurved, mobile, furcate at the extremity and bears two prominences on the dorsal angle which are the origin of setæ.

The carapace is often beautifully reticulated and sometimes there are more than one sort or series of these markings. The Daphinoide are distinguished from Cyproidea by the presence of posterior foliaceous legs, which is considered by Dana as of greater importance than the more obvious peculiarity—the exclusion of the head from the carpace.

Prof. Dana has united the genera of Dr. Baird's *Daphniadæ*, *Polyphemidæ* and *Lynceidæ* in this tribe, and this seems appropriate, since there cannot certainly be as wide a gap between *Daphnia* and *Lynceus* as between the curious *Bosmina* and *Daphnia*, yet the latter two were united in one family and Lyncens separated as totally distinct. The chief peculiarities which lead to the separation of Lynceidæ were first, the fact that they possessed in front of the eye a "black spot" of unknown use, and second, that the head was produced in front to form a more or less prominent beak.

But it has since been ascertained that the black spot is a common feature among the species of the whole tribe and, according to modern authors, is in someway connected with the base of the superior antennæ and serves, probably, as an organ of hearing.

The characters of the head seem to have been misunderstood. In all the species of the Daphinoidea which I have examined, the head seems to be covered with a curved plate or carapace, within which is the insertion of the organs of the head. Now a little change of position under the microscope serves to give to the anterior portion of this covering on acute or obtuse appearance, depending on which side of the carapace is in the focus of the instrument. As the shape of the beak is used as a generic character in this sub-division it seems quite probable that the matter will need further revision. The fact that the intestine is or is not convoluted was shown by Dana to be of no generic importance.

The characteristics of the tribe may be best seen as illustrated in the subdivisions.

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FAMILY 1. PENILIDÆ. Dana.

Bibliography.—Penilidæ, *Dana*. Pro. Amer. Acad. Sci., ii., 47, 1849.
Sidina, *Baird*, Brit. Entomost, 106.
Sididæ, *Gray*, Cat. Brit. Crust. Brit. Mus., 93, 1850.

Characters.—Foliaceous feet twelve, narrow. Anterior antennæ obsolescent.
Genus 1. Sida, *Straus*. Posterior antennæ with the longer ramus three-articulate, shorter, two-articulate. Head not beaked below.
Genus 2. Daphnella, *Baird*. Both rami of posterior antennæ two-jointed. Anterior antennæ borne by the middle of the under aspect of the head.
Genus 3. Penilia, *Dana*. Both rami of the posterior antennæ two-jointed. Head short, produced below. Primary antennæ borne on the extremity. Species marine.
? Genus 4. Latona, *Strauss*. Posterior antennæ having three one-articulate rami.

Only one species of this family has been met with, which is here described.

Genus 1.

Sida, *(Straus.)*

Bibliography.—Sida, *Straus*, Minn. Mus. Hist. Nat., v.
—— *M. Edwards*.
—— *Baird*.
—— *Dana*.
Daphnia, *Mulller*.
——— Latreille, etc.
Monoculus, *De Geer*.
——— *Jurine, etc.*

Generic Characters.—Superior antennæ of moderate size. Longer rami of inferior antennæ with three articulations, shorter rami with two. Inferior antennæ very large and powerful.

Sida crystallina, *Muller*.

Bibliography.—Daphne crystallina, *Muller*, Zool. Dan. Prod., No. 2,405, 1,776.
Daphnia crystallina, *Muller*, Entomost., 96, t. 14, f. 1–4.
——— ——— *Latreille*, Hist. Nat. Crust. IV., 230.
——— ——— *Rose*, Minn. d'Hist. Nat. Crust. II., 281.
Sida crystallina, *Straus*, Minn. Mus. Hist. Nat., V.
Sida crystallina, *M. Edwards*, Hist. Nat. Crust., III., 383.
Monoculus crystallina, *Gmelin*, Linn. Lyst. Nat., edit. 13th, I. 3,000, No. 29.
——— ——— *Manuel*, Enc. Mith., VII. 724, t. 265, f. 15–18.
——— ——— *Fabricius*, Ent. Syst., II. 493.
Monoculus elongatus, *De Geer*, Mem. Servis Hist. Ins., VII. 470, t. 29, f. 1–4, 1,778.

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Description, etc.—General shape that of an elongate rectangular prism, or sub-cylindrical. Carapace elongate oval, truncate before and behind, very transparent, being obviously reticulated only near the anterior portion.

Head large, obtuse in both vertical and horizontal aspect, furnished with a projecting disc or plate on the posterior part of upper surface. Eye round and rather large, red, with many corneæ.

Superior antennæ are quite observable, being rather long and armed with four bristles on the extremity.

Inferior antennæ very large. The basal joint is cylindrical, very large and fleshy, and wrinkled so as to appear many jointed. The two rami are unequal and rather short. The outer ramus has three articulations. The first is short and furnished with a minute spine. The second is longer and has three strong-jointed setæ on the inner margin, and a spine near its articulation with the third, which is of nearly the same length, and has four setæ on the inner margin, three at the end and a small spine at the upper outer angle.

The inner ramus has two unequal joints, the lower of which is much the longer, and is furnished with a spine and a seta, while the second has four large-jointed setæ at the extremity.

The labrum and mandible are similar to those of Daphnia.

The feet are of six pairs, which are described as follows:

The first pair consists of a main stalk of two joints, of which the first has four setæ, and the terminal (or "hand") joint seven. The first joint also has two branchial plates, of which the upper and smaller possesses nine or ten short setæ and one jointed and plumose filament, while the lower or main plate has about thirty plumose setæ. The second, third, fourth and fifth pairs are quite similar, but the stout setæ on the outer margin of the first joint are replaced by a triangular plate and the branchial filaments are shorter. The sixth pair has three articulations, each furnished with straight, stout spines, and is curved. The abdomen has at its extremity two strong, curved claws, which have each three spines on the basal half, and are dentate for the remainder of their length; it also has two tubercles at the angle behind each of which bears a long seta. Between the claws and these knobs are two rows of spines.

The ovary contains in full grown females, about twenty young, which resemble their parent from birth.

The organ on the top of the head is used as a sort of sucker, by which the animal adheres to water plants.

Their motion is rapid and steady. The circulation of the blood can be seen through the transparent walls of the body and head, as in the front part of the head, where the minute, colorless corpuscles are easily seen coursing from above. There appears to be a dorsal vessel just above the intestine in which these globules can be seen as they pass from behind forwards to near the juncture of the carapace with the glabella of the head, where is an enlargement forming the heart, the pulsations of which are uniform with the motions of the branchial feet. The motion of the feet, besides the aeration of the blood, propels (as in others of this family) a strong current of water between the bases of the limbs toward the mouth, bringing to it the particles on which it feeds and which it has no other means of capturing.

This interesting creature is quite rarely seen, whether from its reclusive habits or actual scarcity I do not know, but it deserves the attention of students, as presenting, both on account of its size and transparency and its somewhat anomalous structure, one of the best opportunities of investigating these little known forms.

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Habitat.—"Grassy Lake," a pond tributary during high water to Lake Calhoun, near Minneapolis; also Diamond Lake. The animal seems to be found in lakes not completely isolated, and does not prefer so muddy a situation as most of the Daphnioidea.

The structure of this animal was compared minutely with the description given by Dr. Baird of *S. Crystallina*, and is beyond doubt identical. *Plates VI and VII.*

FAMILY II. DAPHNIDÆ.

Bibliography.—Daphnidæ, *Dana*, Rep. Wilkes' Expl. Exp., p. 1265.
———— *Dana*, Proc. Amer. Acad. Sci., ii., 1849.
Daphnita, *Gray*, Cat. Brit. Crust. Brit. Mus., 88.
Daphniadæ, (part), *Baird*, Brit. Entomos. 62.

Characters.—Foliaceous feet ten. Anterior antennæ one or two-jointed.

1. Head large.

Genus 1. Daphnia, *Muller*, (including Ceriodaphnia of Dana, which differ in the shape of the reticulations of the shell.)
Genus 2. Moina, *Baird.*
Genus 3. Macrothrix, *Baird* (including Acanthocerus of Schodler.)

2. Head short.

Genus 4. Lynceus, *Muller* (including *Eurycercus*, *Chydorus*, *Peracantha*, *Pleuroxis*, *Acroperus*, *Campotercus* and *Alona* of different authors, until some valid generic characters are announced.)

Genus Daphnia, Muller.

Bibliography.—Daphnia, *Muller*, Zool. Dan. Prod.
———— *Muller*, Entomost.
———— *Straus*, *Desmarest*, *Latreille*, etc.
Monoculus, *Linnæus*, *Poda*, *Blumenbach*, *De Geer*, etc.

The Daphniæ are among our most abundant and most interesting Entomostraca, occurring in stagnant water everywhere, they are very prolific and voracious. This genus is confined strictly to fresh water.

The general characters will be gathered from the description of the tribe and of the species. The superior antennæ are usually rudimentary and hidden, but vary with the sexes. The most prominent organs are the inferior antennæ, which are large and powerful. They consist at the base of a single large, fleshy joint which has all possible play upon its attachments. This joint supports two branches of nearly equal length, but the outer is usually four-jointed, while the inner has but three articulations. Each of the last three is furnished with a long seta which is jointed at the middle, and usually pecinate, forming a fine swimming organ. The eye is a large, conspicuous organ near the front and is so furnished with muscles that it has a semi-rotation. This organ occupies a prominence on the underside of the head, which projects backward supporting the minute antennæ and the black spot before noticed. Baird says that the eye was mistaken by one author for the *stomach*. The chief gangilon of the nervous system lies near and communicates with the eye. The mouth lies at the back of the prominence described, and is armed with a labrum, a pair of mandibles and a pair of jaws. For particulars of structure see plate IX.

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The digestive system is the most conspicuous part of the creature when filled. It is then often of a brillant green color, extending along the whole dorsal region. The œsophagus is short, opening into the stomach just behind the brain ganglion. From this point the stomach curves upward and extends thence through the whole length of the animal. The contractile vessicle above the stomach is quite an obvious feature, but Gruithuisen says there are two hearts, one venous, the other arterial, but this is probably not established, though the existence of a dorsal vessel above the stomach is probable from analogy and observed appearances.

The legs, which are of five pairs, vary considerably, but the same plan is preserved. At the base of each is a branchial plate furnished with fine branchial filaments corresponding to gills, while the remaining portions of the leg serve to create currents of water toward the mouth. The result is a vigorous current between the legs under the body, which transports the food particles to the maxillæ. The ovaries are along the sides of the abdomen, and the ova are normally hatched within the shell of the parent above the abdomen.

These creatures have been supposed hermaphroditic, from the extreme scarcity of the males, but they are in this respect like the Aphides, being parthenogenetic. Besides the ova which are hatched within the shell of the living parent, another method is seen. The outside of the carapace grows opaque, and finally two spots appear within which are the eggs. When the moult takes place, the carapace with its burden is left in the water until a favorable time, when the eggs hatch. This obviously is a protection against the cold of winter, for the ephippium, as the carapace thus loaded is called, is thick and horny. The ephippia may be observed in winter, floating about in the water, often in abundance. (See plate IX.)

Daphnia Pulex.

Bibliography.—Monoculus pulex, *Linnæus*, Sys. Nat. 10 Ed., i., 635, No. 4, 1758.
———— *Gmelin*, Syst. Nat. 13th Edit., i., 2999, No. 4.
———— *Poda*, Ins. Mus. Græcus, 124.
———— *Muller*, Faun. Insect. Fredrichsdalens, 95.
———— *Blumenbach*, Handbuch der Naturg., 399.
———— *Manuel*, Enc. nieth., VII., 722, No. 15, t. 265, f. 1–4.
———— *Fabricius*, Entoml. Syst., ii., 497.
———— *Leach*, Encyc. Brit. art. Entoml.
———— *Jurine*, Hist. des Monoc., 85.
———— *Cuvier*, Tab. Element., 455.
Daphene pulex, *Muller*, Zool. Dan. Prod., 199, No. 2400, 1776.
Daphnia pulex, *Latreille*, Gen. Crust. et Ins.; Hist. Nat. gen. et part., des Crust; Règne Anim. Cuv.
———— *Lamarck*, Hist. Nat. des An. s. Vert. Edit. 2, V., 181, No. 1.
———— *Lamouelle*, British Insects, 81.
———— *Straus*, Mem. der Mus. d'Hist. Nat., v. t. 29.
———— *Demarest*, Consid. gén. sur les Crust., 372, t. 54.
———— *Baird*, Ann. Nat. Hist., i., 254.
———— *M. Edwards*, Hist. Nat. des Crust.
———— *Guerin*, Iconograph. Crust., t. 33.
Daphnia pulex, *O. Fabricius* Faun. Grœnland., 263.
———— *Leach* Edin. Encyc., vii. art. Crustaceol.

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Daphnia pennata, *Muller*, Entomost., t. 12, f. 4–7.
———— *Bosc*, Man. d'Hist. Nat. des Crust., ii., 280.
———— *Schrank*, Faun. Boic., iii., 264.
Monoculus pulex arborescens, *Linn.* Syst. Nat.. 4th Edit., 96.
Pulex arborescens. *Swammerdam*, Hist. Nat. Ins. Gen., 76, t. 1, f. o. b. c. Biblia Naturæ, 86, t. 31, f. 1–3.
———— *Goeze* Naturfoscher, pt. 7.
Monoculus pulex ramosus, *De Geer*, Mém. pour servir à l'Hist. Ins., vii., 442.
Daphnia ramosa, *Koch*, Deutsch. Crust., h. XXXV., t. 18.
Daphnia media, *Koch*, Deutsch. Crust., h, XXXVII. t. 1.
Daphnia ephippiata, *Koch*, Deutsch. Crust., h. XXXV t. 16.
Puckron branchu, *Trembley*.
Water-flea with branching horns, *Baker*, Empl. for Micros.
Pou aquatique, *Joblot*, Observ. d'Hist. Nat.
Le Perroquet d'can, *Geoffroy*, Hist. abrég. Ins.
Vermes minimi rubri, *Merrett*, Pmax Res. Nat. Brit.
Ammaletti aquatici, *Redi*, Asservazioni. Opere.
Monoculus, *Bradley*, Phil. Occ. of Works of Nature.
Le Puceron verdatre, *Ledermuller*.

Var. 1. Daphnia longispina, *Muller*.
———— *Latreille*.
———— *Bosc*.
———— *Ramdohr*.
———— *Lamarck*.
———— *Straus*.
———— *Demarest*.
———— *M. Edwards*.
———— *Koch*.
Monoculus longispinus, *Fabricius*.
———— *Manuel*.
———— *De Geer*.
———— *Schœffer*.

Var. 2. Daphnia magna, *Straus*.
———— *Demarest*.
———— *M. Edwards*.

Description.—Carapax oval or sub-quadrangular, transparent, more or less reticulated on all or part of the surface. Head large, more or less beaked. Superior antennæ very small. Inferior antennæ strong and long. The superior antennæ have five small setæ at the apex, while the inferior pair are armed with the usual complement of setæ, which in this species are finely plumose.

The color of this animal, which is our commonest and one of the largest species, is dependent upon the food taken into the stomach, which extends through nearly the whole length of the body in all the species. When feeding upon clean vegetation the intestinal canal is of a brilliant green hue, while at other times it is dark or brownish. In England they are often of a bright red color throughout, but I have never met with such here.

The carapax is terminated posteriorly by a serrated spine, which is variously situated, and varies also with the age of the animal. In one variety the spine is situated at the upper posterior angle while in others it springs from the centre of the posterior aspect. In the young the spine is long, almost equaling sometimes

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the carapax in length, but at each successive moulting the spine is found to be shorter. The upper part of the body has four projections, one of which is longer than the others and serves evidently to keep the ova in position.

Dr. Baird says that "the male is much smaller than the female", which is the case in nearly all the species, "and the superior antennæ are much larger and spring from under the beak instead of from the beak itself. The inferior extremities of the valves are more densely serrated than in the female."

The males are always fewer than the females. The motions of this creature are quick, spasmodic leaps through the water, and it often presents a beautiful appearance.

Daphnia Vetula.

Bibliography.—Daphne vetula, *Muller*, Zool. Dan. Prod., No. 2399.
Daphnia vetulo, *Straus*, Mém Mus. Hist. Nat., V., t. 29, f. 25–6.
———— *Baird*, Ann. Mag. Nat. Hist., i., 255, t. 9, f. 13.
Daphnia sima, *Muller*, Entomost., 91, t. 12, f. 11–12, 1785.
———— *Latreille.*
———— *Bosc.*
———— *Ramdohr.*
———— *Gruithuisen.*
———— *Desmarest.*
———— *Lamarck.*
———— *M. Edwards.*
———— *Koch.*
Monoculus sima, *Givelus.*
———— *Manuel.*
———— *Jurine.*
Monoculus lævis, *Fabricius.*
Monoculus expinosus, *De Geer.*
Monoculus conchacus, *Donovaan.*
Ungeschwauzter-zackiger, *Wasserfloh, Schœffer.*
Monoculus nasutus (?) *Jurine.*
Monoculus pulex, *Sulger.*
Daphnia congener, *Koch.*
Daphnia expinosa, *Koch.*

Description.—In size like *Daphnia pulex*, some forms of which it resembles. Carapax in the male quadrangular with the sides nearly parallel, the posterior prominence being near the dorsal part of the shell. In the female, however, the prominence is near the middle of the posterior side, while the carapax is widest near that extremity. The spine usually present in the larger Daphnidæ is obsolete, but there is a series of small spines or teeth on the upper posterior margin. The lower edge is strongly ciliated. The carapax is strongly lined transversely. These striæ arise from the one or two rows of hexagonal cells which border the lower margin, and anastomose occasionally, giving in some cases a reticulated appearance to the shell. The head is very small proportionately, rounded in in front, and rather strongly beaked below.

The superior antennæ are quite evident. Inferior antennæ large. The first joint is fleshy and stout, margined at the extremity with spines and sending out three branches, of which the two large swimming organs are as in *pulex*, having the plumose setæ, etc. At the base and between these is a third, consisting of a conical point with a broadened base ending in a spinous appendage. The scuta

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of the head seems wider and less arched than in other species. Jaws long and ending in a circle of fine teeth. Feet as in *pulex*.

Seen from above the carapax of the body is found to consist of three pieces The first, which might be termed the scutella, is a small shield adjoining the head, and the two principal pieces or valves of the shell may be considered as appendages of the scutella. These pieces may be compared to the *tergum* and *pleuron* of trilobites.

The structure of the beak and its relation to the head is more clearly seen than in most of the Daphniæ. The head shield as seen from below is transversely sub-oval. Directly in front and very near the anterior margin of the skull is an eye, filling a circular elevation reaching the anterior margin, and sending off posteriorly a ridge or straight partition which divides the lower aspect of the head into two basin-like cavities. This ridge terminates in the beak which carries the superior antennæ and the black spot which Huxley calls an ocular pigment, but by other authors is thought to be attached to the auditory apparatus, and is termed by Dana the "otolites", following Schoder in so considering it. (See *Plates X. and XI.*)

Daphnia Mucronata.

Bibliography.—Daphne mucronata, *Muller*, Zool. Dan. Prod., No. 2404, 1776.
Dapnia mucronata, *Muller*, Entomst., 94.
———— *Desmarest*. Cons. gèn. Crust. 374.
———— *Latreille*, Hist. Nat. Crust., IV., 229.
———— *Bosc*, Man. d'Hist. Nat. Crust., ii., 281.
———— *M. Edwards*, Hist. Nat. Crust. iii., 382.
———— *Baird*, Trans. Berw. Nat. club, ii, 148.
———— Monoculus mucronatus, *Gmelin*, Linn. Syst. Nat., edit. 14th, i., 3,000, No. 28.
———— *Manuel*, Enc. Mith., t. 265, f. 19.
———— *Jurine*, Hist. Nat. Monoc. 137, t. 14, f. 1, 2.
Monoculus bispinosus, *De Geer*, Mem. Servir. Hist. Ins., VII., 463, 1778.
———— *Fabricius*, Ent. Syst., iii., 493.
Daphnia bispinosa, *Koch*, Deutsch. Crust., h. VIII., t. 1.

Description.—General shape, as seen from above, oval. Lower margin of the carapax straight, terminated posteriorly by a curved spine. Head triangular, obtuse in front. Eye large. Superior antennæ small. Inferior antennæ long. Lower part of the carapax ciliated. Color dark. Dr. Baird says that the form of the head varies in this species, being sometimes rounded and at others terminated by a sharp, somewhat curved point directed upwards.

I have not observed in any of the many specimens seen a sharply pointed head; and though this point casts some doubt on the identification, every other point in his description seems to agree very well with our species, which I find no warrant for separating from *D. mucronata* var. *obtuse rostrata*.

Habitat.—Sandy Lake (East Minneapolis), Clark's Lake, Grassy Lake, etc. (See *Plate XII.*)

Daphnia (Ceriodaphnia, Dana) Reticulata.

Bibliography.—Monoculus reticulatus, *Jurine*, Hist. Nat. Monoc., 139, t. 14, f. 3, 4.

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Daphnia reticulata, *Desmarest*, Cons. gén Crust., 374.
M. Edwards, Hist. Nat. Crust., iii., 381.
———— *Baird*, Trans. Berws. Nat. Club. ii., 148.
Daphnia ventricosa (?) *Koch*, Deutsch. Crust., h. XXXV., t. 21.
Daphnia quadrangula, *Muller*, Ent., 90, t. 13. f. 4.
———— *Latreille*, Nat. Hist. Const. IV., 227.
Monoculus quadrangula, *Gmelin*, Linn. Syst. Nat., 2999, No. 24.
Monoculus quadrangularis, *Manuel*, Enc. Mith., VII., 723, No.15.
Monoculus quadrangulus, *Fabricius*, Ent. Syst., ii., 492.

Note.—I was not able to fully satisfy myself that this is certainly identical with the species described by Baird but there are no good reasons for believing it a distinct species. It is round enough for D. *rotunda*. There is an evident spine on the posterior angle of the shell, though it sometimes is almost obsolete.

The reticulations are hexagonal (?). The color in the specimens examined is greenish, and moreover the superior antennæ agree better with *reticulata* than *rotunda*. The size is small.

Description.—Small (.02 in. or over). Carapace oval and comparatively very broad, covered with hexagonal markings. Head small as compared with the body, and more nearly at right angles with it than in most of the Daphniæ. There is also a slight depression a little in front of the juncture with the body. Superior antennæ rather larger than in most Daphniæ, and somewhat movable. Inferior antennæ quite large. Beak none. Feet as in the larger species.

This species is very active on account of the length of the antennæ, which have shorter spines (not plumose) than *D. pulex*. It presents a robust appearance in swimming either on its back or face, since it is much broader in proportion than most other species.

Habitat.—Lake Amelia, Grassy Lake, etc. Not very abundant but widely distributed.

Baird says of this species: "The ephippium differs considerably from that of *pulex*. It is more rounded, white at the centre, with a large round ampulla, containing only one ovum. When the animal has the ephippium on, it possesses a square appearance, and is the *D. qaadrangula* of Muller."

This is one of the commonest species in many of our lakes, while in others it is replaced by the *pulex*, for as yet I have not seen them both in the same locality.

Habitat.—Grassy Lake, Lake Amelia, etc.

(See Plate VII.)

Daphnia spinosa, Herrick.

Description.—General shape of the Daphnia pulex; carapace armed at the upper posterior margin with a rather long, serrated spine. The first of feet are long, bristled at the extremity as in young specimens of D. pulex. The anterior antennæ are larger than in pulex and two-jointed and setæ-bearing at the end. Posterior antennæ exactly as in pulex. The eye is nearer the antennæ than in other species, but the most striking peculiarity is the pointed spine formed by the front of the head, which is very marked. Carapace not obviously reticulated, transparent.

Habitat.—Found in Lake Calhoun, but not in large numbers. It seems to inhabit the deeper waters.

(See Plate XIII., p. 1.)

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GENUS **Macrothrix.**

(Sig.—long hair.)

Bibliography.—Macrothrix, *Baird*, Ann. Mag. Nat. Hist., XI, 87, 1843, and XVII, 412; Trans. Berw. Nat. Hist. club, ii, 149.
Daphnia, *M. Edwards*, Hist. Nat. Crust., iii, 384.
———— *Muller* (?) Entomost.
Lynceus, *Desmarest*, Cons. Gen. Et. Part. Crust., 376.
Monoculus, *Jurnine*, Hist. Monoc. Generc.
Acanthocercas, *Schulder* Ericks, 1846.
Macrothrix, *Dana*, Wilkes' Explos. Exp. Report.

Characters.—Head, beneath, either subacute or rather obtuse, anterior antennæ rather long, pendulous from the beak, eye accompanied by a rather large black spot at the base of the attennæ; seta from first joint of anterior branch of inferior antennæ much longer than the others.

Macrothrix agilis, Herrick.

Description.—Head shield (as seen from above) very nearly square; body carapace pear shaped; eye smaller than in *Daphnia* and accompanied with a rather large black spot similar to the obvious spot in Lynceus, but even larger. Superior antennæ very long in comparison with other members of the family. Inferior antennæ rather large, armed with large setæ, of which the spine from the end of the first joint is extremely elongate and plumose, nearly as long as the body. This joint also has a small spine on the opposite or upper side of the ramus.

The spine from the second joint is larger than in *Daphnia*. The final joint bears a small spine also in addition to the three setæ. (In the drawing both of the rami have the elongate seta. This may be a mistake in the observation, which was made in some haste.)

The jaws, feet, and posterior segments of the body, are similar, as far as observed, to like organs in *Daphnia*.

The lower and posterior part of the margin of the carapace bears a number of long stout spines directed backward. The posterior body filaments, instead of being simple or only plumose, are divided at the extremity into four small bristles, forming a tassel or brush at the end.

The intestine is not convoluted but is more abruptly curved and depressed near the head than in *Daphnia*, thus approaching *Lynceus*.

The motions of this interesting animal are lively and impetuous, it being assisted by the long filaments of the antennæ, which, with the body spines and strong teeth of the shell, give to it a spider like aspect.

This species differs materially from any described by Baird, or any other author with which I am familiar, but even if the elongate filaments should prove to be common to both rami of the antennæ, it must fall in this genus.

Habitat.—Only observed in Rocky Lake, a small pool near East Minneapolis.

Plate XIV.

GENUS **Lynceus,** Muller.

This genus was rejected by Dr. Baird who founded upon its remains a number of genera, most of which were rejected in turn by Prof. Dana, who recognized the following:

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Lynceus, Eurycercus and *Alona.*
Lynceus—Eurycercus of Dr. Baird.
Eurycercus—Chydorus, Percantha and *Pleuroxus.*
Alona—Alona, Acroperus and *Camptocercus.*

In the genus *Alona*, he says. the beak diverges from the body at a large angle (60° to 90°) with the shell adjoining, while in *Lynceus* it is usually curved parallel to it.

But, as Dana himself admits, the distinctions are of doubtful importance, and it would seem preferable to retain Muller's old genus instituted for all of these forms than to further complicate the matter until a large amount of material shall be gathered and compared. The species observed will, therefore, be briefly described and the probable place in the rejected genera indicated.

Lynceus macrourus. Muller.

Bibliography.—Lynceus macrourus, *Muller*, Dan. Prod., 2397.
——— *Latreille*, Hist. Nat. Crust., 207.
——— *M. Edwards*, Hist. Nat. Crust., iii, 388.
Monoculus macrourus, *Genelin*, Syst. Nat., 3008, No. 65.
Monoculus macrourus, *Manuel*, Enc. Mith., vii, 733, No. 68.
——— *Fabricius*, Ent. Syst., ii, 499.
Camptocercus macrourus, *Baird*, Ann. and Mag. Nat. Hist. ii; Trans. Berw. Nat. Club. ii, 150; British Entomost. p. 128.

Description.—Carapace pear-shaped, transparent, finely lined longitudinally, sinuated on the lower margin, which is ciliated for most of its length. Head rather small, with a short, blunt beak projecting straight downwards. Superior antennæ rather large, situated about half way from the extremity of the beak to the body. Inferior antennæ long, with long setæ at the extremity, eyes small, first pair of feet large, abdomen very long and slender, serrated with well marked teeth on the posterior edge and terminating in the usual pair of claws. The extreme length and narrowness of the abomen formed the basis of the genus *camptocercus* of Dr. Baird, this species being the only one described under it. The intestine is convoluted, and there is an opening near the juncture of the last segment of the abdomen with the rest of the body from which a long vessel begins and extends above the stomach, as at (a) Fig. 1, Plate XV. This species is quite abundant.

Lynceus quadrangularis, Muller.

Bibliography.—Lynceus quadrangularis, *Muller*, Zool. Dan. Prod., No. 2393, 1876.
——————— *Latreille*, Hist. Crust., 208.
——————— *Baird*, Trans. Berw. Club.
——————— *M. Edwards*, Hist. Crust., iii., 388.
——————— *Kock*, Deutsch. Crust. L. XXXVI.
Monoculus quadrangulus, *Gmelin, Maduel.*
Monoculus quadrangularis, *Fabricius.*
Monoculus striatus(?) *Jurine.*
Alona quadrangularis, *Baird*, Ann. and Mag. Nat. Hist., ii. 92 Trans. Berw. Club, ii. 151; Entomostraca, p. 131.

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Description.—Carapace ovate quadrangular, but somewhat variable, being in some specimens quite abruptly rounded on the posterior margin, while in others it is almost truncate; shell of a yellowish or brown color, heavily marked and ciliated below. Beak blunt, varying in position in different individuals. Abdomen flat, sinuated at the extremity and bearing long claws. Anterior antennæ of moderate size. Eye rather large. Larger antennæ rather long.

Total length between .03 and .04 in. This species is also quite abundant, and if I am right in referring it to the *L. quadrangularis* of Muller, is quite variable. Drawings made from individuals collected at different localites on comparison show minute differences of form and markings. The intestine is strongly convoluted in this species, but the dark color of the shell usually interferes with observations of the organs within.

Plate XV. fig. 2.

Lynceus sphæricus, Muller. (?)

Bibliography.—Lynceus sphæricus, *Muller.*
————*Latreille.*
————*Lamarck.*
————*Desmarest.*
————*Baird.*
————*M. Edwards.*
————*Prichard.*
————*Koch.*
Monoculus sphæricus, *Gmelin.*
————*Manuel.*
————*Fabricius.*
————*Jurine.*
Monoculus infusorius, *Schrank.*
————*Eichorn.*
Chydorus Mulleri, *Leach.*
Chydorus sphæricus, *Baird*, Ann. and Mag. Nat. Hist. ii. 89, t. 2; Brit. Entomst. p. 126.

Description.—Baird's description of this species is applicable to any one of several almost equally, and the only recourse seems to be a reliance on the figure he gives with which our species seems to correspond quite well.

The shell is round and nearly blunt behind, the antennæ are quite small, so that the animal rolls slowly along like a corpulent sailor on land. Not enough attention has been devoted to this and the following species of the genus. Length, .03 in. Plate XIII, fig. 2.

Lynceus sp.?

See L. (Pleurus) trigonellus, P. uncinatus etc. cf Baird.

The animal figured in Plate XII, Fig. 3, evidently belongs to the genus *Pleuroxus* of Baird. In examining several specimens the turned up beak was found in several cases while in others it was seen as represented at (3a) of the same plate. Dr. Baird separated two species on the ground of this variation, but it does not seem to be a specific character. The length is .03 in. in the species seen, and except that the shell is longer in proportion, agrees pretty well with L. trigonellus, Muller.

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Lyncœus sp.?

Another member of the genus differing from any description met with is shown in plate XVI. It is the smallest form seen, not exceeding .02 in. The feet are proportionally large, as is the eye, while the antennæ are quite small.

FAMILY Bosminidæ.

This family has been removed, by Prof. Dana, (justly it would seem to us) from *Dahpnidæ*. The general appearance is unique, and the characteristics of the superior antennæ places the only member in the single genus composing this family at quite a distance from Daphnia and its allies.

Characteristics.—Foliaceous feet, ten in number; anterior antennæ elongate and many-articulate.

GENUS Bosmina.

Bibliography.—Daphnia, *M. Edwards.*
———— *Desmarest.*
———— *Baird.*
Monoculus, *Jurine.*
Lynceus, *Muller.*
———— *Latreille.*
Bosmina, *Baird*, Trans. Berw. Nat. Club, 1845; Ann. Mag. Nat. Hist. VI., 412.

NOTE. (Name)—"Bosmina," a daughter of Fingal.

Generic characters.—Superior antennæ long, curved, cylindrical, consisting of many small articulations, and projecting from the extremity of the beak; inferior antennæ small as compared with size of the body.

Bosmina longirostris.

Bibliography.—Lynceus longirostris, *Muller*, Zool. Dan. Prod., No. 2394; Entomost., 76.
————*Latreille*, Hist. Nat. Crust. IV., 206.
————*Fabricius*, Ent. Syst., ii., 499.
Monoculus cornutus, *Jurine*, Hist. Nat. Monoc.
Daphnia cornuta, *Desmorest*, Cons. Gen. Crust.
————*Baird*, Ann. Mag. Nat. Hist. ii., 257.
————*M. Edward*, Hist. Nat. Crust., iii., 382.
Bosmina cornuta, *Baird*, Trans. Berw. Nat. Club.
Eunica longirostris, *Koch*, Deutsch Crust., h. XXXV. t. 23.

Description.—General form varying from nearly square to an irregular pear shape (the large portion anterior); carapace terminated on the lower posterior margin by short, curved spines. Head of moderate size, eye large, superior antennæ long, projecting from the beak, consisting of many articulations, the seventh joints furnished with setæ. Inferior antennæ small. Ova few.

The length of this animal is less than .02 in., which makes it a difficult matter to clearly discover the structure of the organs.

The superior antennæ are nearly immovable, and being closely in juxtaposition, give the appearance of a long, jointed beak or trunk. In fact, the first idea

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suggested by this bizarre creature is a peculiar burlesque on the elephant. It requires favorable light and a high power to study the nature of the antennæ. The feet are apparently wider than in Daphnia. Under a favorable light, the carapace is seen to be reticulated with hexagonal cells (at least near the edge) and is covered, in some specimens at least, by exceedingly minute tubercles. The motion is steady, progressive, and not saltatory, as in many *Daphniæ*, which is due (as in Lynceæ) to the shortness of the antennæ. The species from which this description is drawn may be distinct from the *longirostris* of Baird, but on comparing both alcoholic specimens and drawings made from living specimens, no differences of importance were detected. The reticulated and tuberculated nature of the shell may be a local variation, or may have easily escaped his notice. The form of the shell demonstrably varies, and so probably does the number of apparent joints to the superior antennæ. The species was found in only one locality, having been dipped with a bottle from the bottom through the ice. but the time of collection is lost. Later, careful search was made during autumn, but no specimens rewarded the pains. The markings, and jointing of the antennæ would make good tests for microscopes of moderate power, for such as are interested in this subject.

Habitat.—Johnson's lake, Minneapolis.

(See Plate XVII.)

TRIBE III. CYPROIDEA. Dana.

Characters.—Dana gives the following: "The Cyproidea differ from all other crustacea except the *Lernæoids* [and *Rotatoria*] in the absence of the pairs of appendages belonging to all the normal cephalothoracic segments posterior to the eighth, that is, to the six posterior of these segments. The last two of these six pairs are obsolete in all the *Lophropoda;* and in the *Cyclopoidea* and *Daphnioinea* the first four of them are natatory and foliaceous, together with also another pair, next anterior in most species. The pairs of appendages present in the Cyproidea posterior to the mandibles, in number four pairs, are divided variously between mouth and legs." This tribe embraces two families, only one of which is represented in our locality, and aside from the general characters of the oceanic family we must confine ourselves to the other.

FAMILY I. **Cypridæ.** Dana.

Characters.—Antennæ of the second pair subterete, three to five-jointed. Mandibles two-branched, the main branch or body, denticulate at the extremity, the minor branch, or palpus several-jointed, palpus remote from the apex of the mandible; eyes with their pigments united, minute, with spherical lenses. Feet either two or if more, slender and pediform.

SUB-FAMILY 1. CYPRINÆ. Dana.

Bibliography.—Cypris, *Muller* and others.
Cyproides (in part) *M. Edwards*, Hist. Nat. Crust.
Cypridæ (in part) *Baird*, Trans. Berw. Club. ii, 153.

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Cypridæ, *Baird*, Brit. Entomost., p. 130.

Characters.—Feet, two pairs; anterior slender and pediform, posterior weak; Abdomen elongate, bearing two clawed appendages.

The cyprinæ, in common with all the members of this tribe are enclosed in a brittle, mussel-like shell which hides from view, in general, all of body and members, except the extremities of the two pairs of antennæ and a pair of feet. They vary in size from an animal of sufficient size to be easily watched with the naked eye, and resembling a small *Unio* in shape and color, to creatures so minute that it is with the greatest difficulty that the valves of the shell are removed without destroying the parts within completely. This peculiarity of these animals renders them among the most difficult in all this order to study. The shell is usually opague. and sometime beautifully colored and fringed. When, however, the soft parts within are separated from the crustaceous envelope the beauty and peculiarity of the structure well repays the student. The shell is composed of two valves, which are only united for a short part of the dorsal margin, and which are held together by muscles which are under the control of the animal. These valves are symetrical with each other in general and are covered by a sort of varnish, which seems to repel the water so that when the creature takes air within the valves of the shell, and hence floats upon the surface it is impossible to cover it with water to prevent the glitter from the surface, while the air within prevents, by its refraction, a view of the interior in such as are transparent. On removing the shell the body is seen to consist of two parts, of which the anterior, or cephalothorax, is considerably the larger and is furnished with organs as follows: first, the eye, situated on the upper portion of the anterior aspect, which, according to Baird, has no crystallines. By Dana, however, two lenses are described; second, the superior antennæ, which are in general seven-jointed, and setigerous. These organs are always kept in vigorous motion when the animal swims. The setæ are sometimes plumose; third, the inferior antennæ. These are more like feet than antennæ and are five-jointed, and in one genus abundantly covered with (sometimes plumose) setæ. In all they are furnished with strong claws at the extremity; fourth, mandibles, which are composed of two parts, the main portion consisting of a triangular plate terminating below in a curved neck, bearing at the end a number of teeth. From the base of the neck arises a second portion, which is three or four-jointed and setigerous. From the end of the first joint of this palpus springs a small plate (branchial?) which has several fine filaments; fifth, first pair of maxillæ. These organs consist of a basal portion and the proper maxillæ which are of two rami, each ramus being furnished with setæ. There is also an attached branchial plate extending within the shell directed upwards and backwards; sixth, maxillipeds. These organs vary in Cypris. As figured by both Dana and Baird, they are of two rami, or have a "maxillary process," but in the species of *Candona* here figured they seemed to resemble the maxillipeds of the *Cyclopoidea*; seventh, first pair of feet. These are five-jointed and terminate in a strong hooked-claw which is directed forward, opposing the second pair of antennæ.

The second portion of the body or abdomen has but two sets of appendages, which are the second pair of legs and the caudal stylets. The second pair of legs are slender and four-jointed, and are directed backward along the abdomen. The caudal appendages are long and terminate in two claws. The anus opens between them. Of the other organs little or nothing is known. Baird was in doubt whether they were hermaphrodites or one copulation sufficed to render the mother and her offspring fertile for life, as in *Daphnia*. I have, however,

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observed copulation in *Cypris*, and the peculiar organs represented in the plate of *Cypris* seem to be restricted to the male, so that it is certain that the sexes are distinct.

These minute creatures moult frequently, casting off in the process the minutest hairs as well as the shell.

This sub-family contains two genera, both of which are represented by a few abundant species within our limits.

GENUS 1. **Cypris**, Muller.

Characters.—Antennæ of the second pair furnished at the end with a bundle of long hairs, by means of which the animal swims freely in the water. The structure is that of the sub-family.

It is very difficult to characterize the species, and it will be necessary to rely chiefly on the figures, since there is little variation in internal structure between the species.

Cypris vidua, Muller. (?)

Bibliography.—Cypris vidua, *Muller*, Zool. Dan. Prod. No. 2384.
————*Latreille*, Hist. Nat. Crust., IV. 245.
————*Bosc*, Man. d'Hist. Nat. Crust.
————*Desmarest*, 385, t. 55, p. 4.
————*Baird*, Trans. Berw. Club, ii. 152.
————*M. Edwards*, Hsst. Nat. Crust., iii. 399.
Monoculus viduus, *Gmelin*, Linn. Syst. Nat., 3002, No. 42.
————*Manuel*, Enc. Méth., vii., 726, No. 36.
————*Jurine*, Hist. Nat. Monoc., 175.
————*Rees*, Cyclopedia, art. Monoc.
Monoculus viduatus, *Fabricius*, Ent. Syst., ii. 496.

(I here give Dr. Baird's description verbatim for comparison with the figure.)

Description.—"Shell of oval form, a little sinuated on the under margin, and beset all round with dense, fine, short hairs. The color is dull white, and the valves are distinctly marked with three black, somewhat waved fasciæ running transversely across the shell at equal distances, the most anterior of the three being smallest. Posterior margin rather narrower than anterior."

This species, if it be the one figured beyond, is the most abundant of this family here, inhabiting all the pools and lakes. It is quite small, appearing as a small speck, either floating on the surface or swimming rapidly about, with a sort of running motion, reminding one of the haste of an excitable man, in its seeming uncertainty and briskness. In figure 1, the shell is represented as transparent, to indicate the position of the organs. The size and shape of the dark bands upon the shell vary in different individuals.

(See Plate No. XVII. fig. 1.)

Cypris neglecta, Herrick.

This species is apparently different from any other which I have seen described The size is very small, little exceeding .01 in. in length. The shape is, as seen from the side, a very perfect oval, not sinuate below, but narrower posteriorly

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than in front. The lower edge of the shell is rather straight, while the upper narrows behind, to form the more acute apex. The color is dull white, without markings of any kind. The shell is more gibbous than any of the other species seen, and is quite glabrous.

The antennæ and feet are not protruded as far as in vidua. This species is also abundant.

Plate No. XVII. fig. 2.

GENUS **Candona**, Baird.

Baird's Brit. Entomost., p. 151.

Characters.—Distinguished from Cypris by the absence of the tuft of long hairs on the secondary antennæ, and the consequent creeping method of locomotion, and, perhaps, by a difference in the form of the maxillipeds.

Candona ornata. Herrick.

Resembles in size C. lucens of Baird, and is of somewhat the same shape. The lower posterior margin is acute, the lower margin is sinnated and the whole margin is beset with hairs. The edge of the shell is also bordered by a series of of markings; the antennæ of the second pair are totally without setæ as far as observed; the shell is white and opaque with pearly lustre. This species is not very gibbous. (See Plate No. XX., Fig. 1.)

Candona (?) elongata. Herrick.

Shell reniform, very elongate, white, glabrous; the umbones of the valves are about two-thirds the distance from the anterior to the posterior dorsal margin; the portion of the shell anterior to the prominence thus formed is narrower than the posterior. It is questionable whether this be a member of the genus *Candona* or in reality a *Cypris*. The animal is quite large and the structure was more clearly made out than in the above. The same pair of bodies seen in the male *Cypris vidua* was found in this animal, the form of the maxillipeds, moreover, was found to differ from that given under the genus *Cypris* by Dana. It is to be hoped that some one may be able to devote a little patient study to this group and clear up the habits and structure as well as the history.

SUB-FAMILY II. CYTHERINÆ.

Cytheridæ, *Baird*, Brit. Entomostraca, 162.

Characters.—Feet six, all slender, alike and pediform.

Genus 1. Cythere, *Muller*.
Shell thin and light, tail short.

Genus 2. Cythercis, *T. R. Jones*.
Shell corrugulate or tuburculate, animal unknown.

FAMILY II. HALOCYPRIDÆ.

This family includs two sub-families and three genera of oceanic species differing in almost all the organs from the above.

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SUB-ORDER **PHYLLOPODA.** (sig. Leaf-footed.)

Bibliography.—Phyllopoda, *Latreille*, Hist. Nat. Crust., IV., 130, 1802.
————*Leach*, Dict. Sc. Nat. XIV., art. Entomost.
————*M. Edwards*, Hist. Nat. Crust., iii., 351.
————*Desmarest*, Consid. Gen. Crust., 357.
————*J. E. Gray*, Synops. Brit. Mus., 1842.
————*Burmeister*, Organiz. of Trilobites, 34.
————*Lucas*, Explor. Sc. de l'Algerie, Crust., 81.
Phyllopa, *Latreille*, Cuv. Règne Anim., IV., 171.
Branchiopodes Lamellipedes and Branchiopodes, *Geans* (in part), *Lamarck*, Hist. An. S. Vert., V.

Characters.—Number of abnormal feet greatly multiplied.

TRIBE I. ARTEMIOIDEA.
Family 1.—Artemiodæ (Branchipodidæ.)
Family 1.– Nebaliadæ.

TRIBE II. APODOIDEA.
Family 1.—Apodidæ.

TRIBE III. LIMNADIOIDEA.
Family 1.—Limnioidæ (Estheridæ. ?)

ARTEMIOIDEA.

Bibliography.—Branchipiens, *Edwards.*
Branchiopoda, *Leuch.*
Branchipodidæ, *Baird.*

Characters.—Cephalothorax many-jointed, either covered by the carapace or not. Appendages of the cephalothorax many, foliaceous and branchiform. Eyes peduncled.

Artemioidea includes *Chirocephalus, (Branchipus) Eulimene, Artemia, Branchinecta, Eubranchipus, Streptocephalus, Nebalia, etc.* These agree in having peduncled eyes, divided posterior thoracic legs and a straight abdomen terminated by spines or plates. This tribe is quite naturally divided into the two families of which *Nebalia* constitutes the one, while the remaining genera fall quite readily into the other.

FAMILY **Artemiadæ.**

Bibliography.—Branchipoda, *Leach*
Branchipiens, *Edwards.*
Branchipidæ, *Burmeister.*
Branchipusidæ, *Baird*, 1845.
Branchipodidæ, *Baird*, later.
————Most modern authors.

Characters.—Cephalothorax many-articulate as far as the head, but nowhere covering the body. Feet foliaceous and numerous.

Dana subdivides this family, forming of the genus *Eulimene*, which has twenty-two branchial feet, the sub-family *Eulimeninæ*, leaving *Chirocephalus, Artemia*, etc., as the

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SUB-FAMILY CHIROCEPHALINÆ.

Characters—Body slender, abdomen long and many jointed, antennæ of the second pair in the female very short and broad, while those of the male are prehensible.

GENUS **Chirocephalus.** (Sig. hand-headed.)

Bibliography.—Chirocephalus, *Prevost*, Jour. de Rhys., lvii., 37, 1803.
———— *Thompson.*
Branchipus, *M. Edwards.*
———— *Fischer.*
———— *Latreille.*
———— *Desmarest.*
———— *Guerin.*
———— *Lamarck*, etc.
Ino, *Schrank*, 1803.
———— *Oken.*
Cancer, *Shaw.*

Some member of this sub-family was found, during the autumn months, in a pool by the road-side but no accurate drawings were made and attempts to re-discover it have failed, so it remains uncertain what species it was. A figure is given of *Chirocephalus diaphanus* and the following discription, mostly from Dr. Baird's work, will serve both for a better understanding of the genus and for comparison, when other specimens are obtained.

The head consists of two segments, the posterior of which is more slender than the anterior, and is usually called the "neck."

The antennæ are very important in the whole group, as furnishing basis for classification. The superior antennæ are alike in male and female, and are filiform, straight, many-jointed, and very flexible. At the extremity are a number of small setæ. The joints of these antennæ are with difficulty seen. The length equals the head. The inferior pair of antennæ are curious organs, from which the genus derives its name, and have been mistaken for madibles and various other entirely different organs.

They are essentially prehensile organs, and consist chiefly of two large appendages, which occupy the forepart of the head, and are curved downward toward the thorax. They are articulated about the middle of their length; the first joint being large and fleshy and having a short, movable, conical appendage on its external edge; the second being curved, cylindrical, somewhat flattened at its extremity, and bearing a strongly toothed process at the base.

Arising from the base of the first joint of each of these appendages is another set of organs, called by Shaw "the trunk." These each consist of a long, flat, curved, very flexible body, composed of many short joints the edges of which are acute, giving a toothed appearance to this organ. From the outer edges of these arise four long and flexible appendages, which are toothed near the end, and also a triangular plate which is folded like a fan when not in use. (This is removed in figure b of plate 1, but shown at d.) These organs are generally carried rolled under the head, somewhat in the manner of the proboscis of a butterfly, being only visible externally as a protuberance.

These prehensile organs are used in retaining the female during copulation. In the female they are much more simple, being simply two flexible, horn-like bodies, carrying none of the appendages which pertain to the male.

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The eyes are large, convex and compound, and are situated on rather large peduncles, which are movable; the mouth consisting of a labrum, a pair of mandibles and two pairs of jaws.

The thorax consists of eleven segments, each bearing a pair of branchial feet, which are large and foliaceous, and consist of three joints. The first is the largest, and has on its lower edge a semicircular branchial plate, which is furnished with about forty plumose hairs; the second joint of the feet bears on its inner side three projections, each of which sends off long hairs; the third joint is long, bearing plumose setæ.

The abdomen is composed of nine segments, which are devoid of appendages, except the two terminal plates, which are beset on their edges with plumose setæ. In the female there is an external oviferous pouch.

The dorsal vessel or heart, commences near the head, and traverses the whole length of the body. When fully grown it is upwards of an inch in length, slender, of a cylindrical form, and nearly transparent. The male has a reddish tinge throughout. The tail is of a beautiful red; the basal joint of the prehensile antennæ a bluish green tipped at the end with red. The back of the female is bluish, and the ovary brown.

These are beautiful animals, and may be seen in fine weather balancing themselves, near the surface of the pools they inhabit, by means of their branchial feet; but when disturbed they strike the water from right to left, and dart away like a fish, to conceal themselves among the weeds at the bottom of the pond.

GENUS **Branchineota.**

Characters.—Form rather slender, with the medium appendages longest, so as to somewhat resemble *Artemia* in outline, but larger; male with rather slender, rounded, two-jointed claspers. Egg-pouch much elongated.

GENUS **Eubranchipus.** (Verrill.)

Characters.—Body robust; made with large head and very stout claspers; first joint of claspers much swoolen, capable of retracting base portion of the second joint into their cavity; second joint stout at the base, in the typical species with a large tooth on the inside, the outer portion tapering, rather obtuse. Front of head between the claspers bears two thin, flat tapering appendages. Caudal appendages long. Egg-pouch short and thick.

GENUS **Streptocephalus.** (Baird.)

Characters.—Male claspers long, three-jointed, tortuous; terminal point subdivided more or less into two branches, or bearing slender appendages. Male organs long and slender. Egg-pouch elongate or conical.

GENUS **Artemia.**

Bibliography.—Artemia, *Leach*, Dist. Sc. Nat., XIV.
Artemisus, *Lamark*, Hist. An. S. Vert. (2d edit.)
Artemis, *Thompson*, Zool. Res., 104.

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Characters.—Clasping organs three-jointed; egg-pouch short, broad; living in more or less saline waters.

The members of this genus, which will be often referred to, are peculiarly interesting from the way in which they show the great and sudden changes that a change in the invironment, is competent to effect in animal forms.

Three species are known in the United States, one of which is found in the eastern states, another in Utah, and still another in California, viz: *gracilis*, *monica*, and *fertilis*.

SUB-FAMILY EULEMENINÆ.

Characters.—Abdomen almost obsolete; both pairs of antennæ filiform.

GENUS **Eulimene.** *(Latreille.)*

FAMILY NEBALIDÆ.

Characters.—Antennæ large and ramiform; eyes peduncled; feet twelve pairs; carapax large, enclosing head, thorax and part of the abdomen, as in a bivalve shell.

GENUS **Nebalia.**

Bibliography.—Nebalia, *Leach*, *Thompson*, *Desmarest*, *Latreille*, *M. Edwards*, *Bosc*, *Lamarck*, etc., etc.
Cancer, *O. Fabricius*, *Herbst*..
Monoculus, *Montagu*.
Myses, *Olivier*.

Being the only genus in the family, the above characters also characterize the genus.

TRIBE II. APHODOIDEA.

Bibliography.—Apusiens (in part), *Edwards*.
Apodidæ, *Burmeister*.
————*Baird*.

Characters.—Body straight; cephalothorax covered by a scuteliform shell; posterior appendages of the thorax lamelliform; abdomen many-jointed; eyes sessile.

FAMILY **Apodidæ.**

Bibliography.—Apus, *M. Edwards*, Hist. Nat. Crust., iii., 356.
Phyllopoda, *Leach*, Edin. Encyclop. VII., art. Crustaceology.
Apodidæ, *Burmeister*, organization of Trilobites, 34.

Characters.—Of large size, with a rounded carapace partially covering the base of the abdomen, which is elongate and ends in two many-jointed, caudal filaments; about sixty pairs of swimming feet; antennæ rudimentary; first maxillipeds antenniform.

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GENUS **Apus.** (Sig. without feet.)

Bibliography.—Apus, (see above for family.)
Monoculus, *Linnæus, Fabricius.*
Binoculus, *Geoffroy, Leach.*
Limulus, *Muller, Lamarck.*
Trilopes, *Schrank.*

Characters.—Antenniform maxillipeds long; telson squarish.

GENUS **Lepidurus.**

Characters.—Body much shorter than in *Apus.* First maxillipeds shorter, and a long, spatulate, keeled telson projecting beyond the insertion of the caudal filaments.

Query—Should not this be reunited with *Apus?*

TRIBE III. LIMNADIOIDEA.

Bibliography.—Apusieus (in part), *Edwards*

Characters.—Body covered completely by a carapace which includes abdomen and head; eyes sessile, like *Cyproidea* in appearance.

FAMILY LIMNADÆ.

Characters.—Body compressed, with ten to twenty-seven feet, inclosed in a bivalve shell.

GENUS **Limnetis.**

Characters.—Shell small, round globose, without lines of growth or umbones; feet-bearing segments ten to twelve.

GENUS **Limnadella.**

(Uncertain. The species upon which it was founded are not now known.)

GENUS **Estheria.**

Shell oval, more or less globose, *Cyclas*-like with numerous lines of growth, amber-colored; animal without a "*haftorgan*"; second antennæ, with from eleven to seventeen joints to the flagella; from twenty-five to twenty-seven segments behind the head; feet twenty-four to twenty-eight; anterior feet in the males with clumsy hooks.

GENUS **Limnadia.**

Shell large, with four or five lines of growth, sub-triangular or broadly ovate; animal with a knob-like projection ("*haftorgan*") above the eyes; second antennæ with nine or ten joints to the flagella; feet eighteen to twenty-six; body much smaller than in *Estheria.*

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GENUS Cyzicus.

(Am not familar with any description of the generic characters.)

Remarks on the Sub-Order.—The species of this sub-order are scattered rather sparingly over the world, and many of them are dependent on peculiar circumstances for their perfect development, as in the case of *Artemia* (or Brine Shrimp) which is found in the waters of salt lakes and in the brine tubs of salt manufactories.

Of the family *Artemiadæ* several species occur throughout the United States. No *Chirocephalus* has been found west of the Rocky Mountains. *Artemia* occurs in many places, as, one in Great Salt Lake, one in Mono Lake, California, and one in the eastern U. S. The genus *Branchinectas* which has a representative in Greenland and in Labrador, has also a species in Colorado, 12,800 feet above the sea. I am not informed that any species of *Nebalia* occurs in North America.

The tribe *Limnadioidea* is without a known representative east of the Mississippi and north of San Domingo. But in Greenland and the arctic regions, *Lepidurus glacialis* is found. West of the Mississippi and east of the Rocky Mountrins are three species of *Apus*, and there has been another found on the Pacific, at Cape St. Lucas. Geologically, the genus is found in European rocks in the Triassic, and our own rocks will probably furnish species.

In the *Phyllopoda* the abdomen and thorax are merged together, and in all but the family *Artemiadæ*, there is a large carapace covering most of the body. In the *Limnadidæ* this shell is large and double, and resembles the small *Cyclas* shells of fresh water, and are often collected by Conchologists as such. The eggs are round or polygonal, and are dense and tough-shelled. The eggs are carried in an ova-sack similar to that of *Cyclops*, or in the *Limnadiadæ*. They are borne under the shell, as in *Daphnia*, etc. The young, as in other *Entomostraca*, hatch from the egg in the "Nauplius stage" described more particularly under *Cyclops*. The difference between the sexes is usually sharply defined. The process of reproduction is very interesting in many species of this sub-order. The normal method of reproduction is perhaps less common than what is known as parthenogenesis, or virgin reproduction. The eggs are produced by a simple budding process from the ovary, without fertilization by the male. The proportion of males to females is very small. In some localities the males are entirely absent. In *Artemia* the amount of saline matter in water seems to vary the comparative number of males. This affords a curious parallel with the sexual changes in the pupa of the honey bee. The saltness of the water not only affects the young, the form of the parent also varies. Schmankiewitsch found near Odessa, Russia, a species of Artemia, and by studying it discovered that it changed its form to correspond with the greater or less saltness of the water. Toward the end of the summer, when the rain and cold weather set in, the *Artemia* increases in size, and the July generation has many differences from the later ones. He then attempted to verify his observations by artificial breeding. He increased the concentration in one case and lowered it in the other, and found that after a series of generations the two sets of animals varied between themselves, and also both differed from those of the pond from which they came. He also learned that males were only produced in water of medium strength.

In the genus *Apus* similar parthenogenetic broods are produced. Siebold's experiments, which have been made with great care and minuteness, have established this fact beyond doubt.

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There is great need of further investigation in this subject, and we are glad to learn that it is about to receive attention from so competent hands as Dr. Packard's.

The systematic position of the sub-order is still a matter of doubt, and it is not yet possible to make any positive classification of the divisions of the *Entomostraca*.

(See Plates XVIII. and XIX.)

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ADDENDA.

Since these pages were written the Bulletins of the Illinois Museum of Nat. Hist. have come under my notice, which, aside from other interesting matter, contain descriptions of many new species of crustacea inhabiting the water of that state. Fine descriptions are given of the following species of Entomostraca, to which the student is referred, viz:

Eubranchipus serratus, Forbes.
Canthocamptus Illinoisensis, Forbes.
Diaptomus Sanguineus, Forbes.
Eubranchipus Bundyi, Forbes.
In Bulletin No. 2, Prof. Forbes describes or mentions the following:
Eurycercus lamillatus, Mull.?
Bosmina, sp.?
Ceriodaphnia angulata, Say.
Daphnia pulex, L.?
Daphnia galeata, Sars.

Later study shows that there is yet much to be done in simply verifying the species which occur here, not to mention the ever remaining opportunity for more minute study of the structure of known forms, for aside from the whole genus *Cyclops*, which has not yet been attempted, and contains numerous species, new species are constantly being met with, among which are those described beyond.

FAMILY PENILIDÆ.

Genus Daphnella. Baird.

Bibliography.—Daphnella, *Baird*, Brit. Entomost., 809.
———— *Dana*, Wilkes' Exp. Crust., page 1267.

Another member of this interesting family has been found since the text was sent to press.

The genus *Daphnella* is characterized by Dana as follows: Posterior antennæ with both rami two-jointed, the shorter ramus often imperfectly three-jointed: Head oblong, not produced beneath, bearing the anterior antennæ near the middle. *Daphnella* differs from *Sida*, which it greatly resembles, even in

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minute structure, in the number of joints of the antennæ and from *Penilia*, in having the first joint of the longer ramus shorter than the second.

The branch which is three-jointed in *Sida* is not the one which has the short terminal joint.

Daphnella Winchelli. Herrick.

This species closely resembles *D. Wingii*, Baird, but I have no hesitation in pronouncing it distinct. Length .03 in. Head rather short. Carapace pear-shaped, transparent. Superior antennæ short, but appearing on either side the head when the animal is swimming, they appear to have three setæ at the extremity. Inferior antennæ very long, as long as body. The shorter ramus has four setæ on the terminal joint and one on the first, while the other ramus carries eight on the terminal joint besides one that is much shorter than the others, and the first joint has four.

The tail has long diverging stylets, and seems not to have the minute teeth of the *D. Wingii*. The posterior portion of the front of the shell-margin is ciliated or spined. The back of the head seems to have the same appendage described in *Sida*. Ova two. This species was found in Minnetonka creek and is named in honor of Prof. Winchell.

FAMILY POLYPHEMIDÆ.

Genus Polyphemus. Muller.

Bibliography.—Polyphemus, *Muller*, *Cuvier*, *Latreille*, *Strous*, etc.
———— *Baird*, Brit, Entomost. p. 111.
———— *Dana*, Wilkes' Exp. p. 1266.

Characters—Body incurved toward the head except the posterior portion of the abdomen, which projects backward and is very slender, bearing two long spines at the extremity. Head distinct. Rami of posterior antennæ three, and four-jointed.

Polyphemus occidentalis. Herrick.

Length .25 in. Body excessively incurved, as is the head. Eye large, filling the head. Superior antennæ apparently obsolete. Inferior antennæ small. Jaws two or three-jointed, three-toothed at the apex. Feet, four pairs, first pair long, apparently four-jointed and three-clawed at the end, basal portion ciliated on the posterior margin. Fourth pair of feet nearly rudimentary. The abdomen is very long. Found in "Mud Lake," south of Minneapolis.

Eurycerus lamellatus. Muller?

Several specimens belonging to Baird's genus *Eurycercus* were found, and as far as can be determined they are not specifically distinct from *E. lamellatus*, though they are less in size and have a few minor points of difference.

I append his description, omitting the bibliography:

"Shell of an olive color; rather square-shaped, ciliated on anterior margin; ventricose in centre, and arched on posterior edge. Beak rather blunt and short, superior antennæ stout, somewhat conical, slightly curved and terminating in

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six spines, each of which gives out a fine seta. Inferior antennæ short compared with the size of the insect. Anterior branch has five long filaments, three from the terminal, and one from each of the other joints. The posterior branch has short spines on the two basal joints. Eye large. Abdomen very wide and densely ciliated. This is the largest member of the family, its motion is a succession of bounds. This animal is heavy and slothful compared to other species.

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PLATE I.

Diaptomus longicornis, Herrick.—Back view of the female and side view of the male. *a*, basal portion of male antennæ showing geniculating joint.

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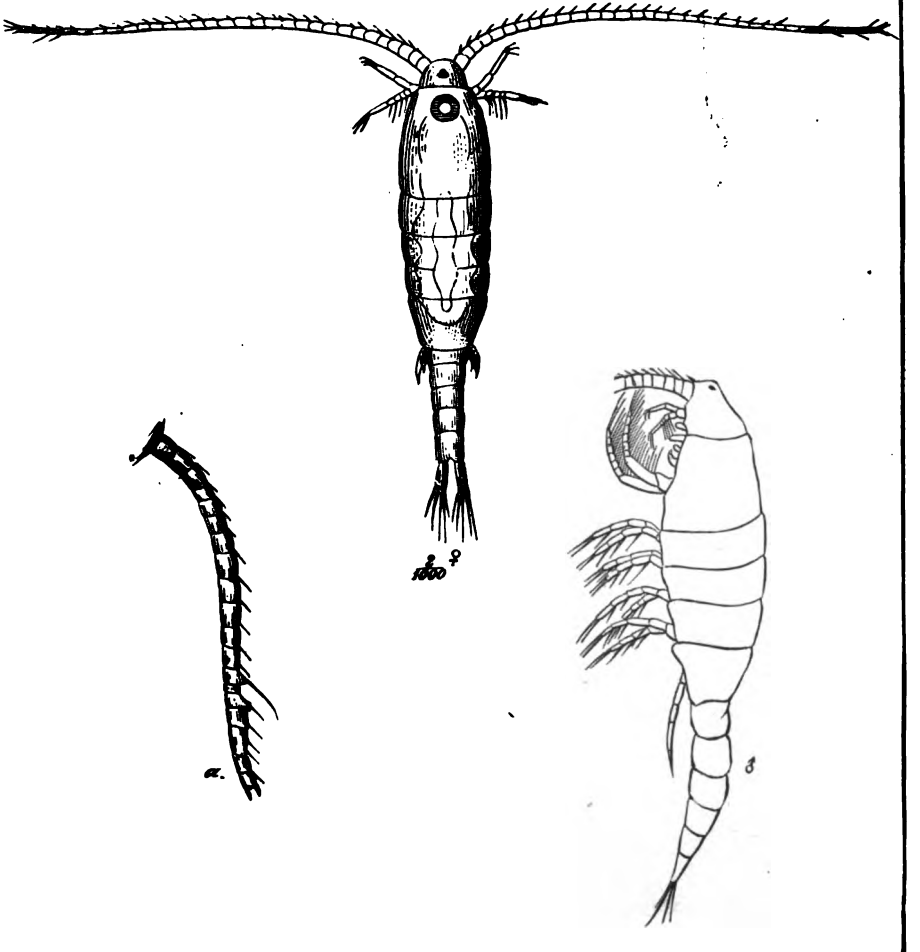

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Plate I.

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PLATE II.

Diaptomus pallidus, Herrick.—Back view of female. (In this plate the antennæ are represented far too short.) *a*, maxilliped. *b*, fifth pair of feet. *c*, extremity of male antennæ. *d*, extremity of female antennæ.

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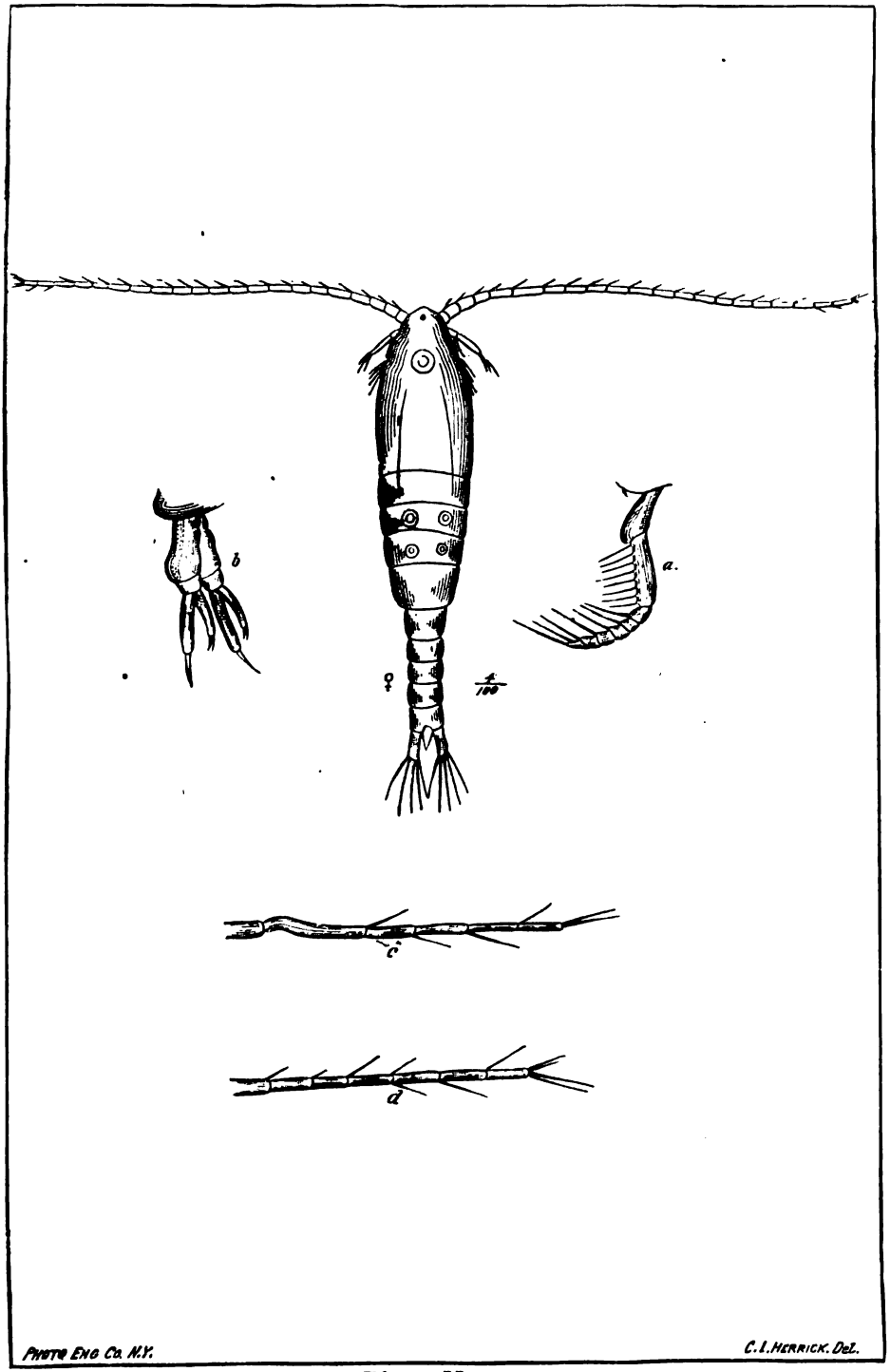

Plate II.

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PLATE III.

Cyclops quadricornis, Linn.—1, mature female with egg sacks containing ova. *a*, egg. *b*, young just born. *c*, young eight days old. *d*, young fifteen days old. *e*, young seventeen days old. *a'*, mandible. *b'*, first pair of foot jaws. 2, side view of mature cyclops.

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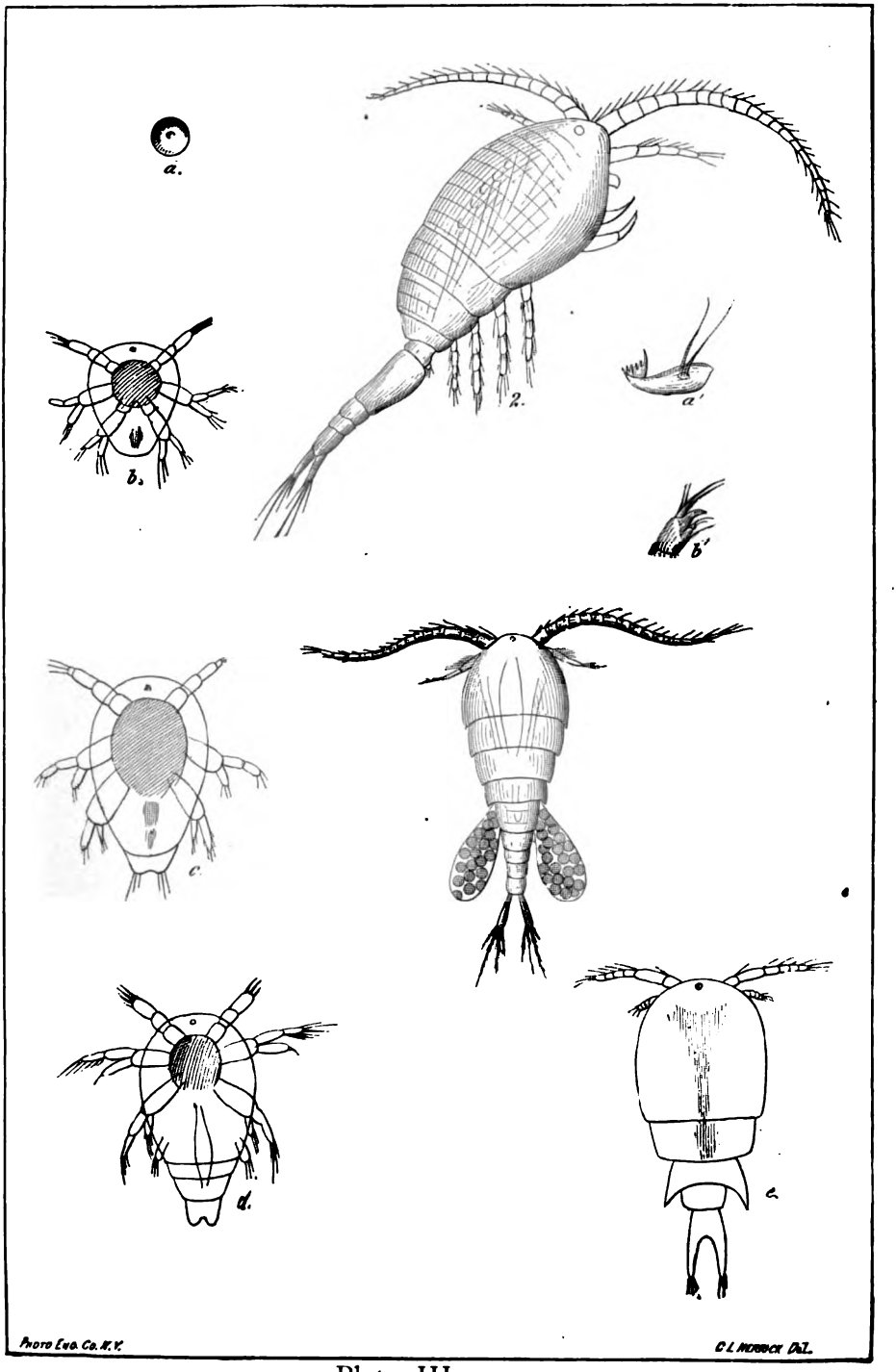

Plate III.

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PLATE IV.

Cyclops quadricornis, Var?—*a*, last pair of feet. 1, 2, 3, 4, 5, feet. 6, inferior antennæ.

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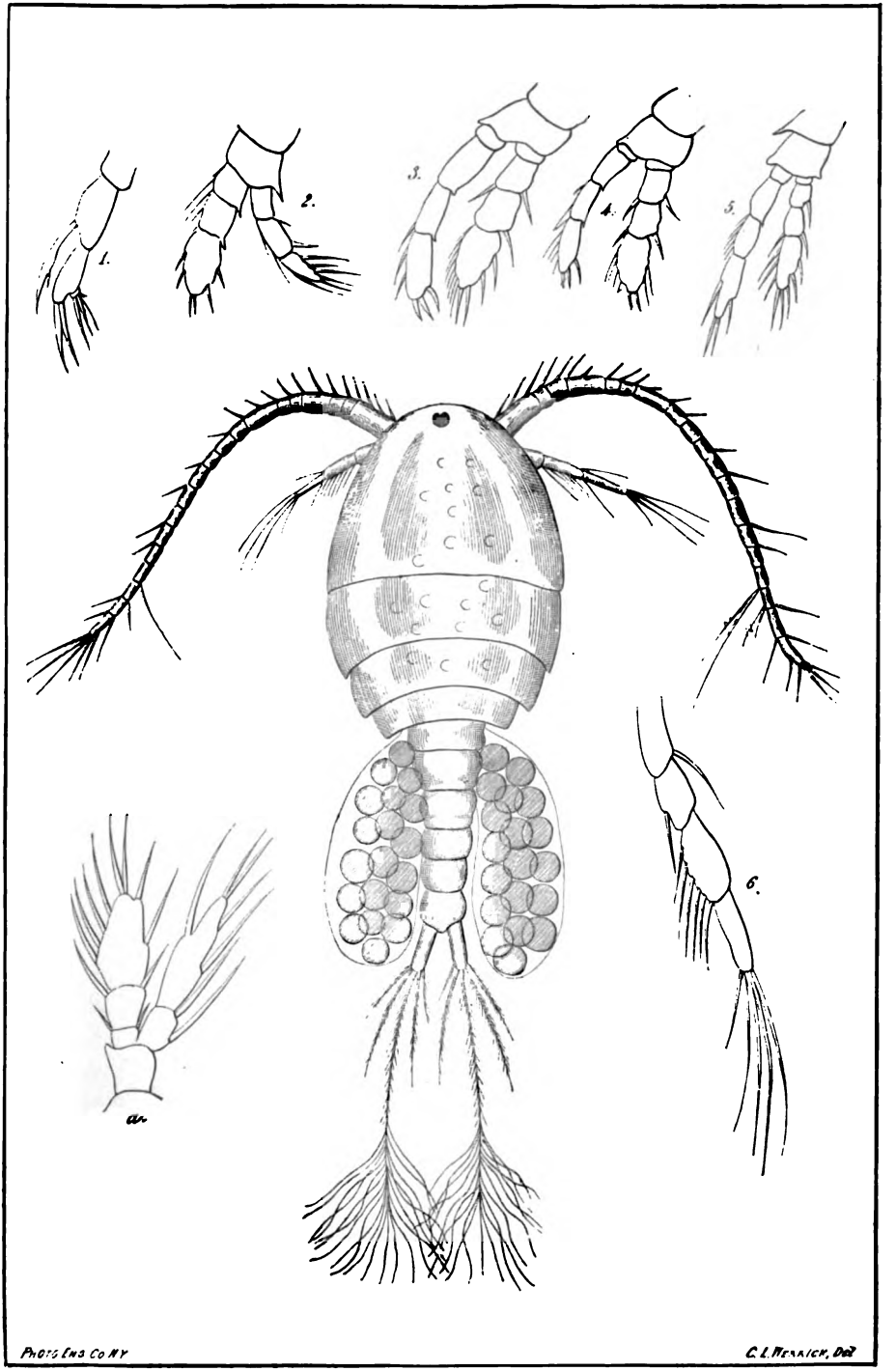

Plate IV.

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PLATE V.

a, *Canthocamptus minutus*, *var. occidentalis*, Herrick, male.
b, do., side view.
c, young, or Nauplius.
d, underview of head of male.
e. external ovary and appendage of female.
f, antenna of male.
g, antennæ of female.
i, foot of first pair.
k, appendage to abdomen of female. (Fifth pair of feet.)
h, foot of second pair.

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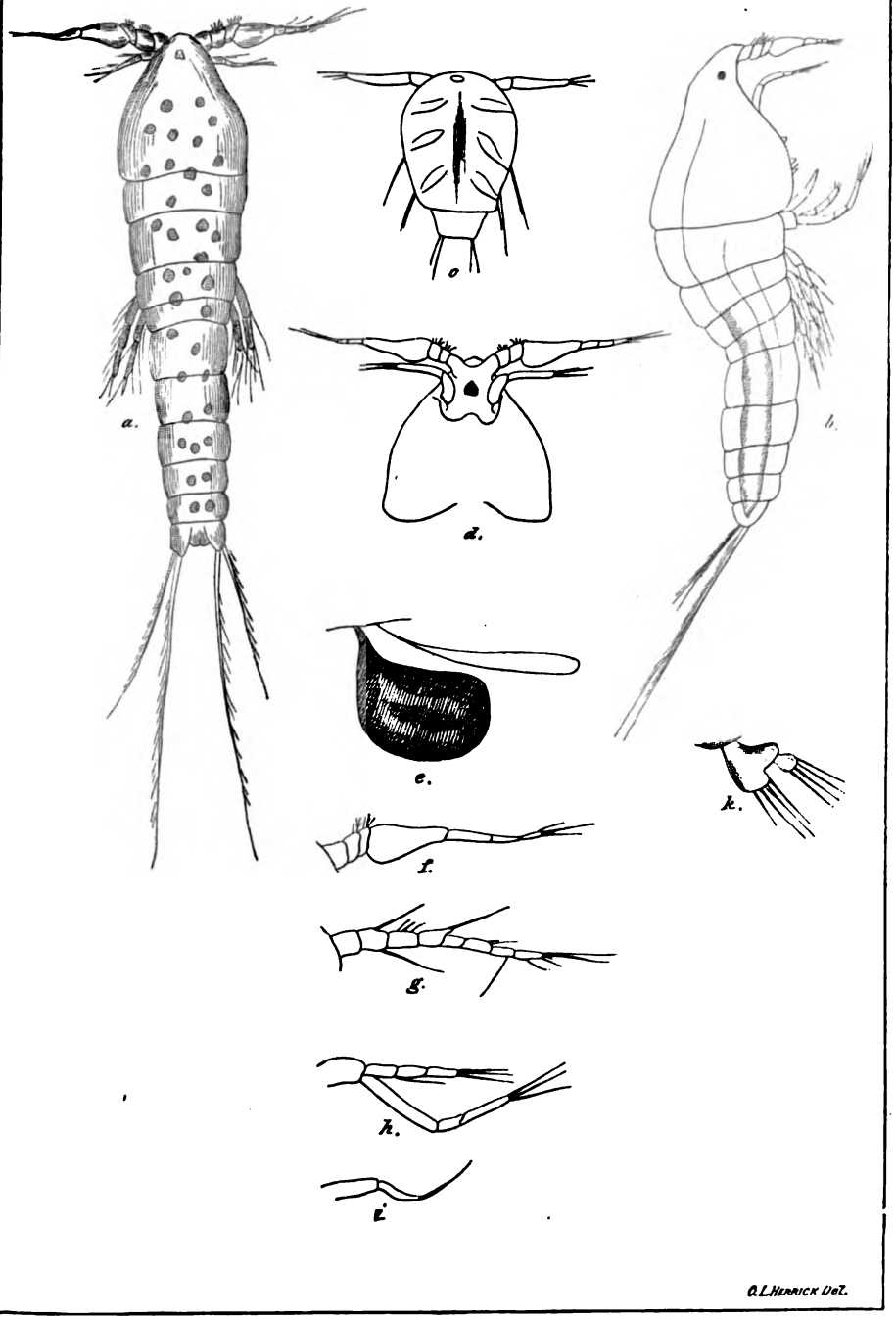

Plate V.

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PLATE VI.

Sida crystallina, Straus. *a*, *b*, *c*, feet of first, second and last pairs. *d*, jaw. *e*, extremity of abdomen. *f*, superior antennæ.

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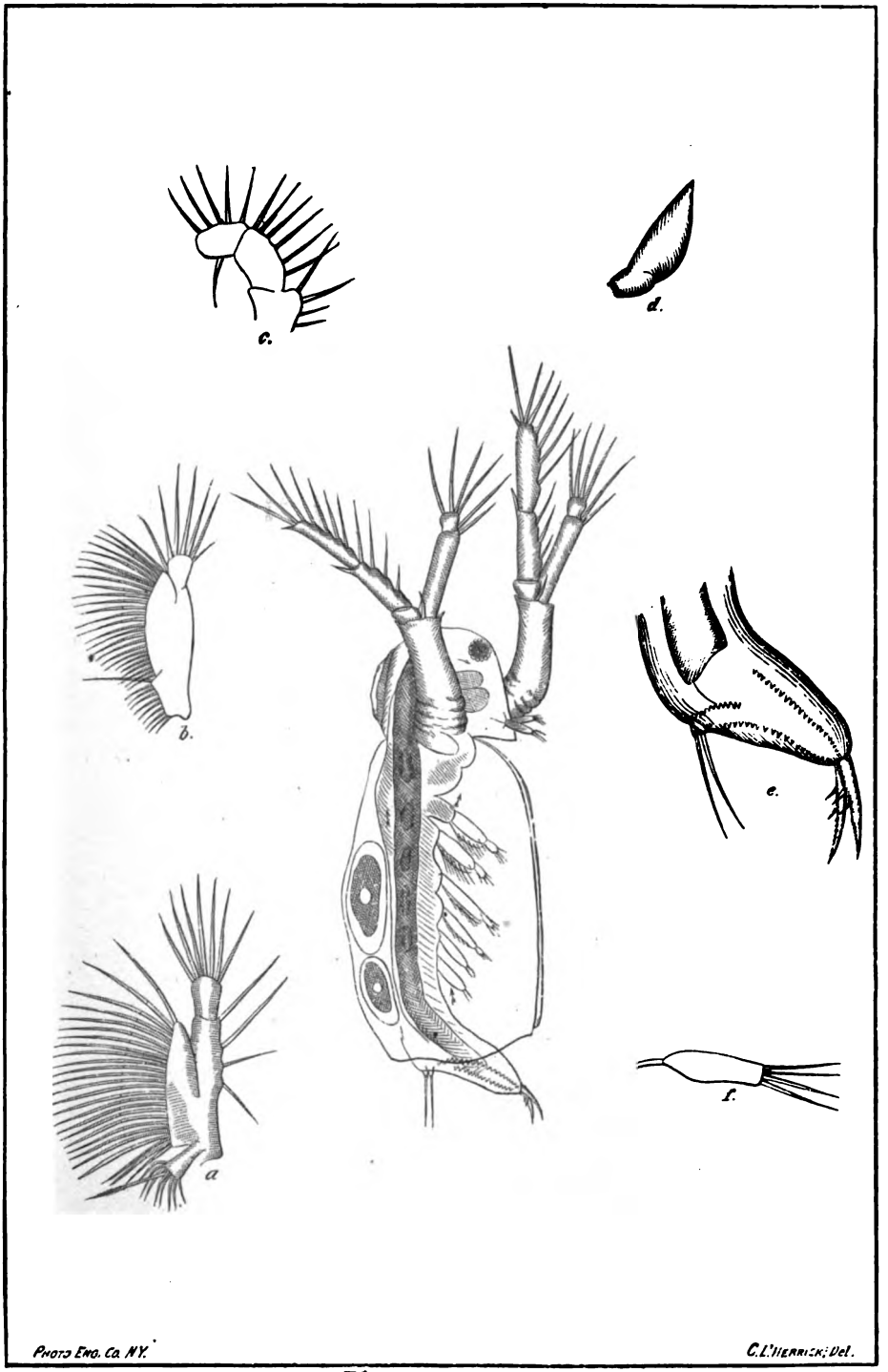

Plate VI.

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PLATE VII.

1. *Daphnia reticulata.* *a*, superior antennæ, *b*, heart.
2. *Sida crystallina.* *a*, head.

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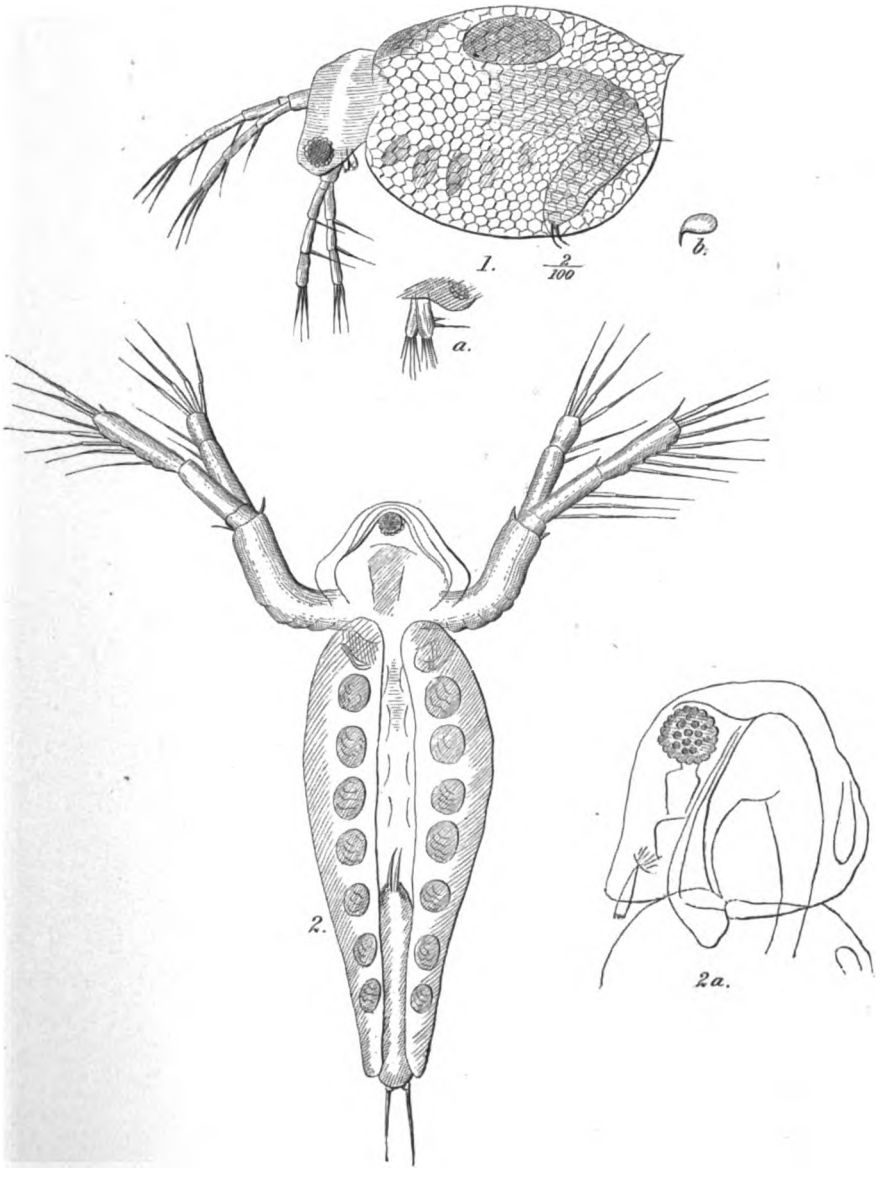

Plate VII.

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PLATE VIII.

1. *Daphnia pulex*, var. 1.
2. ——— ——— var. 2.
3. ——— ——— var. 3.
   (*a*) foot.

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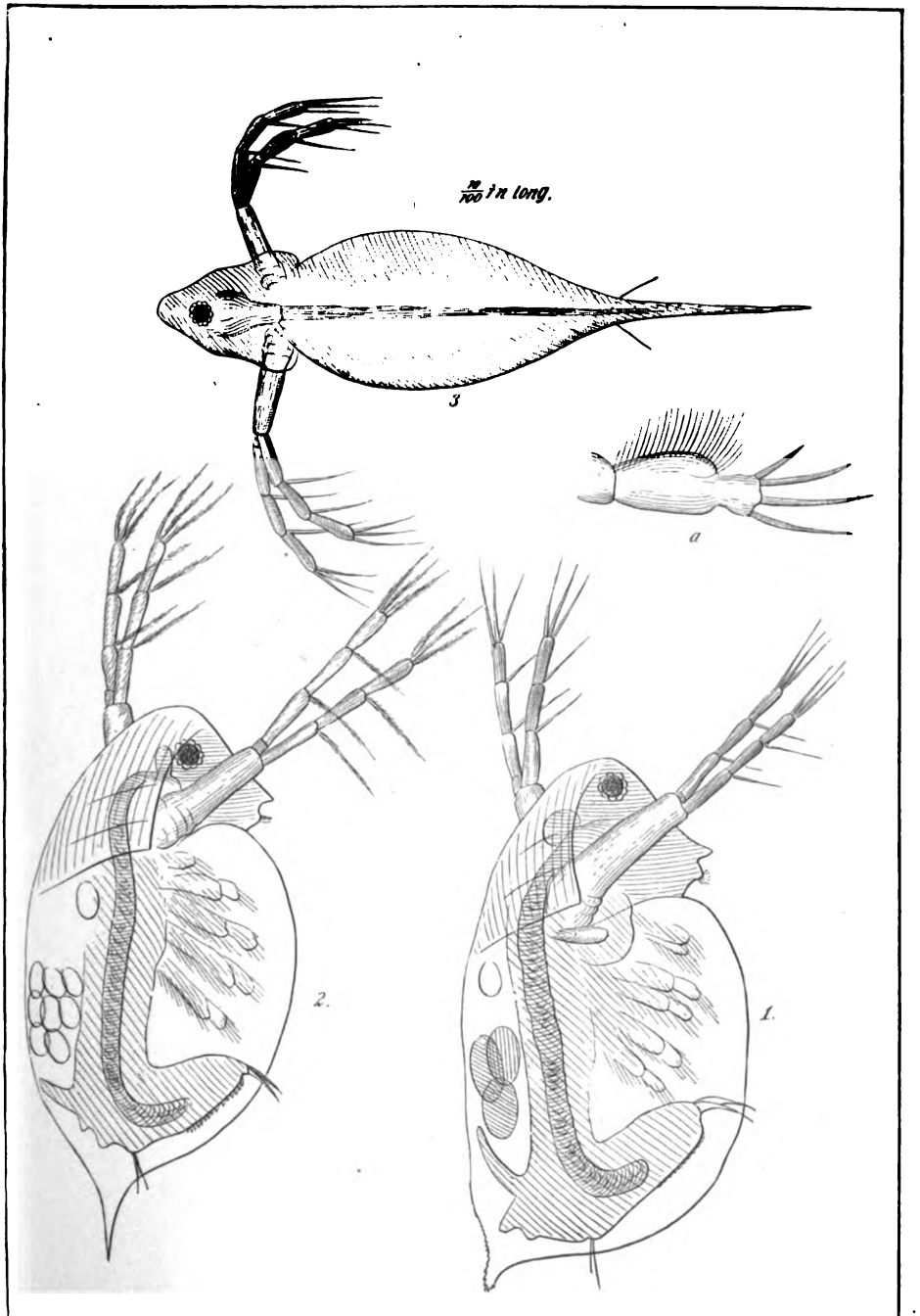

Plate VIII.

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PLATE IX.

Fig. 1. Head of Daphnia Schæfferi showing alimentary apparatus etc., antennæ removed. *a*, heart. *b*, stomach. *c*, cæcum. *d*, superior antennæ. *e*, eye. *f*, labrum. *g*, jaw. *A*, *B*, *C*, *D*, *E*, one of each pair of feet.

Fig. 2. Superior antennæ.

Fig. 3. Posterior portion of body.

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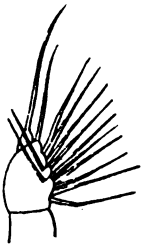
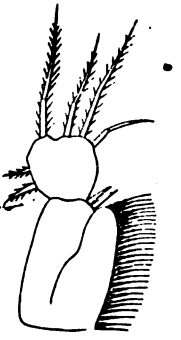


A.

B.



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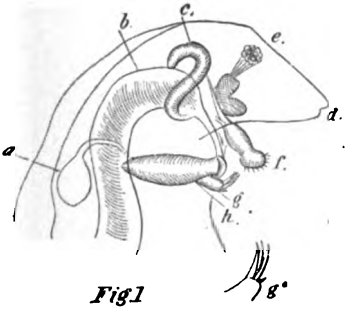
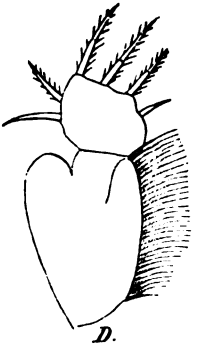


Fig 1



D.

E.

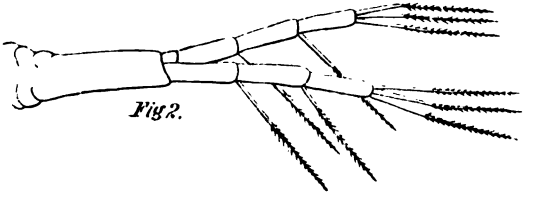


Fig 2.

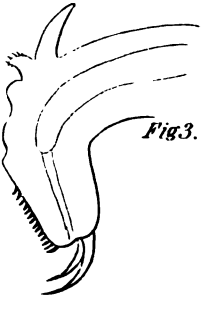


Fig 3.

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Plate IX.

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PLATE X.

Daphnia vetula.—1, under view. 2, side view. 3, young extracted from egg. *a*, one of the setæ from the antennæ. *b*, jaw. *c*, base of the two rami of the superior antennæ. *d*, end of abdomen.

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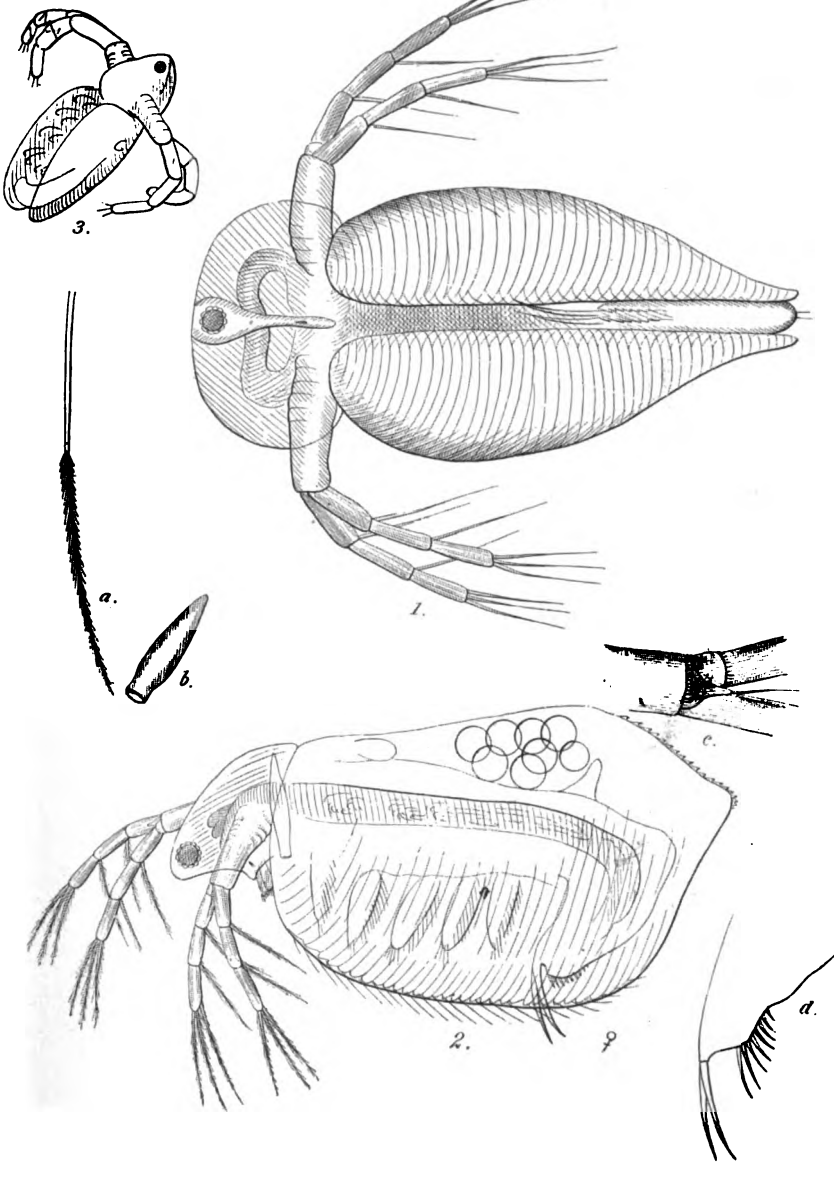

Plate X.

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PLATE XI.

Daphnia setula, male and female. *a*, jaws.

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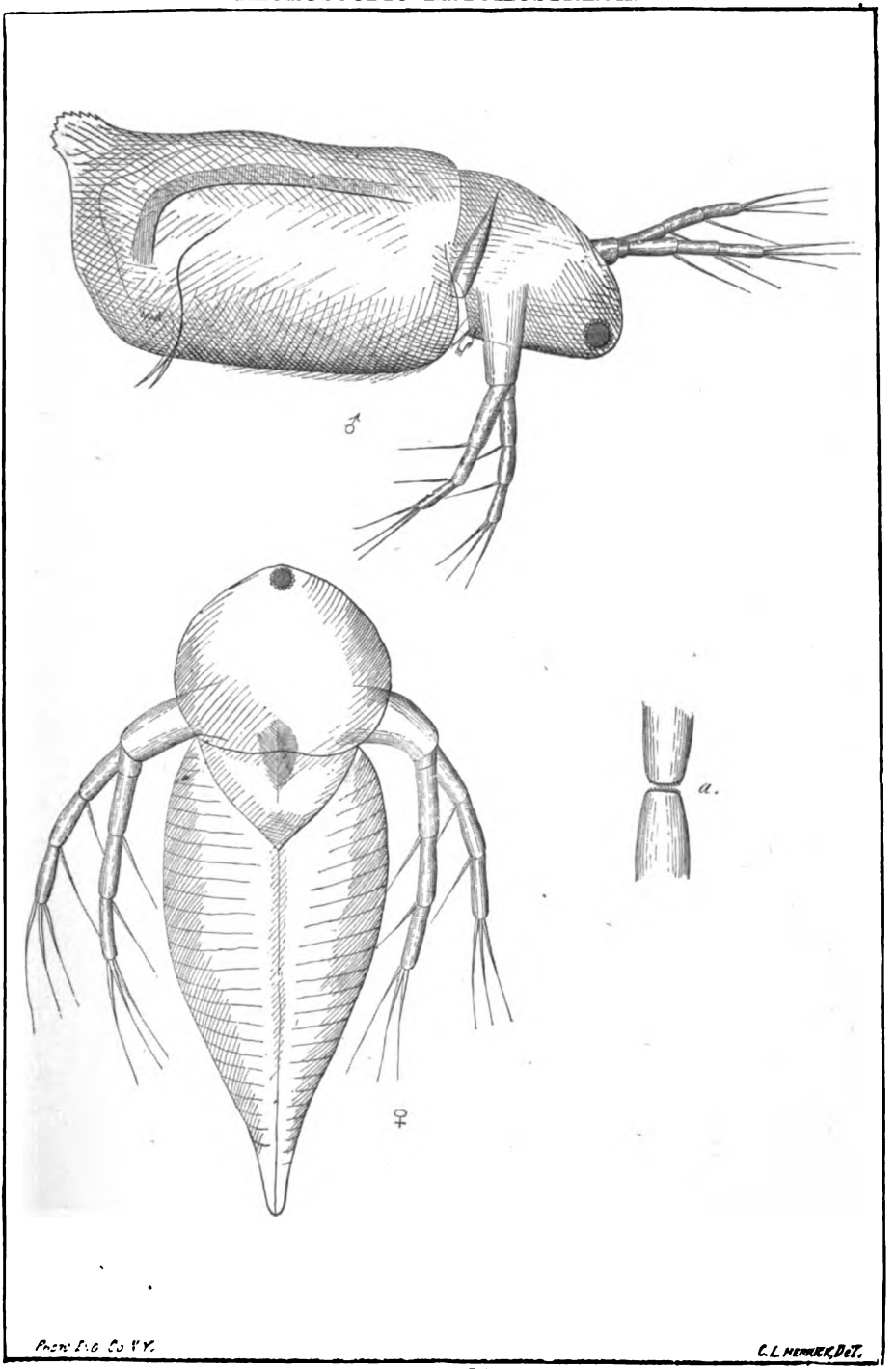

Plate XI.

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PLATE XII.

Daphnia mucronata. *a*, head and eye.

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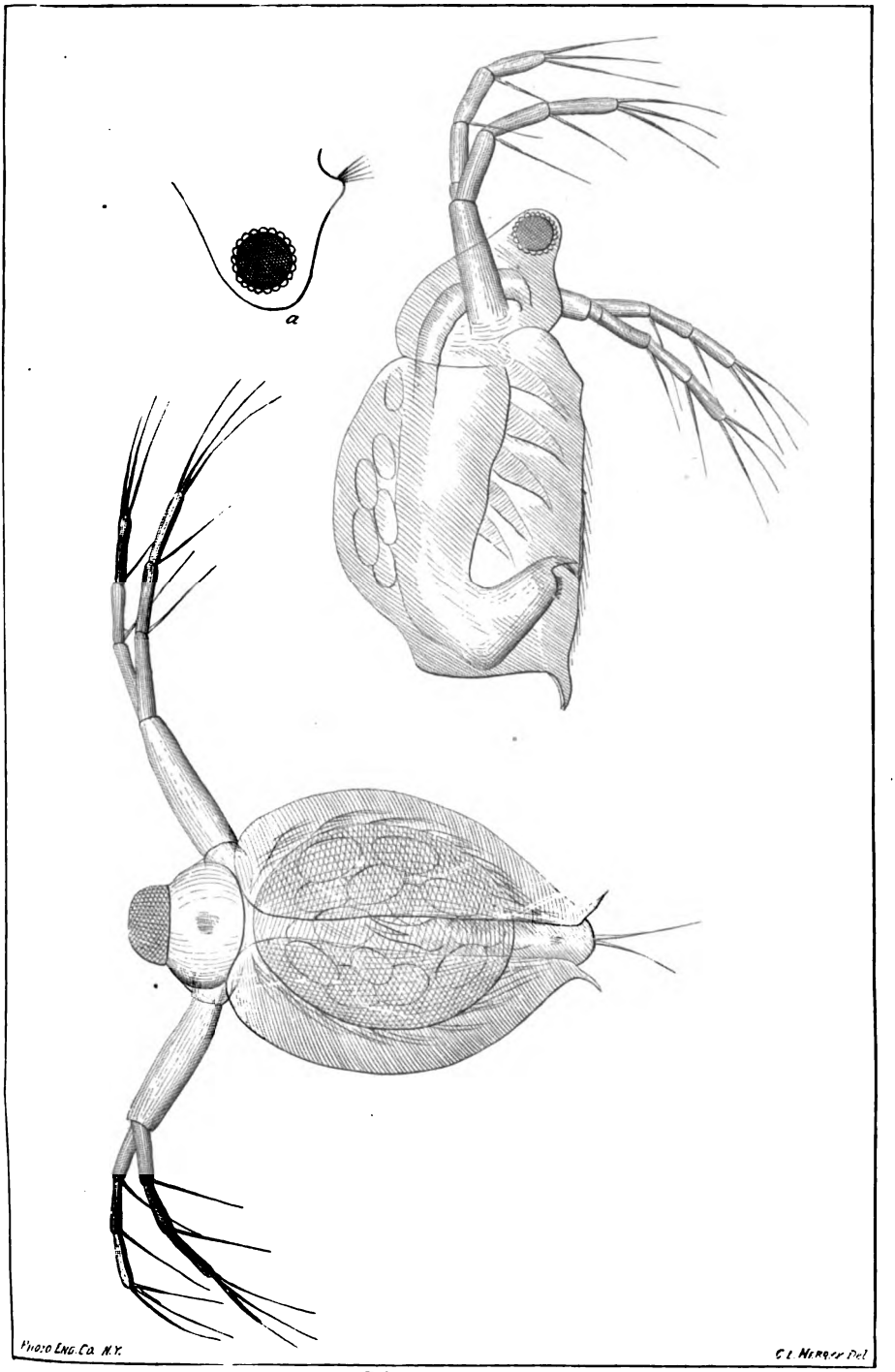

Plate XII.

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PLATE XIII.

1, ***Daphnia spinosa***, Herrick.

2, ***Lynceus sp.?***

3, ***Lynceus sphæricus***.

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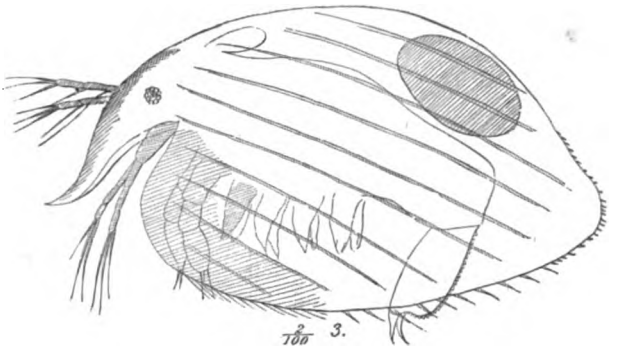
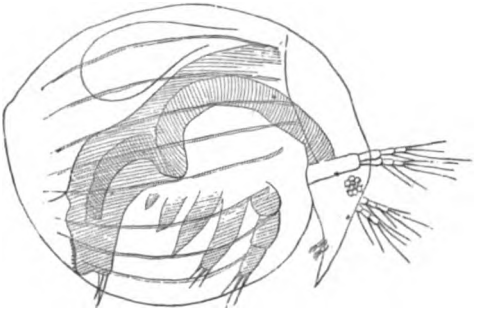
3a.

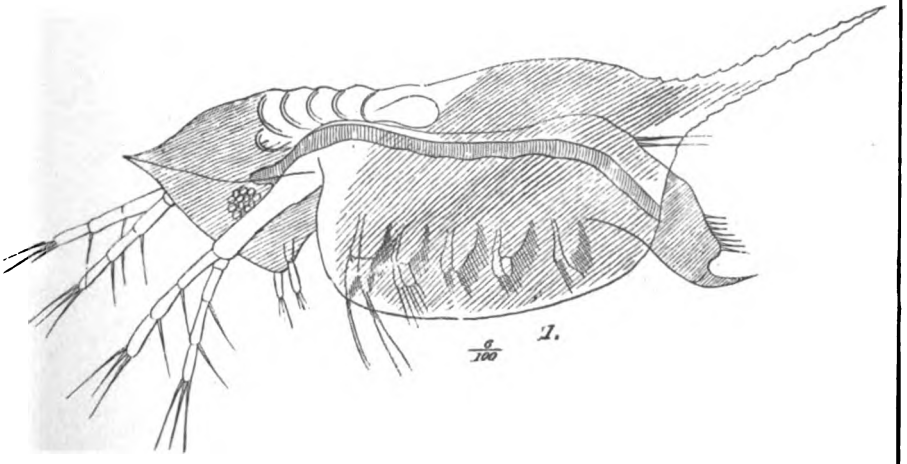


$\frac{5}{100}$ 3.



2a.

$\frac{3}{100}$



$\frac{6}{100}$ 1.

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Plate XIII.

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PLATE XIV.

Macrothrix agilis, Herrick. Two views. *a*, tail spine.

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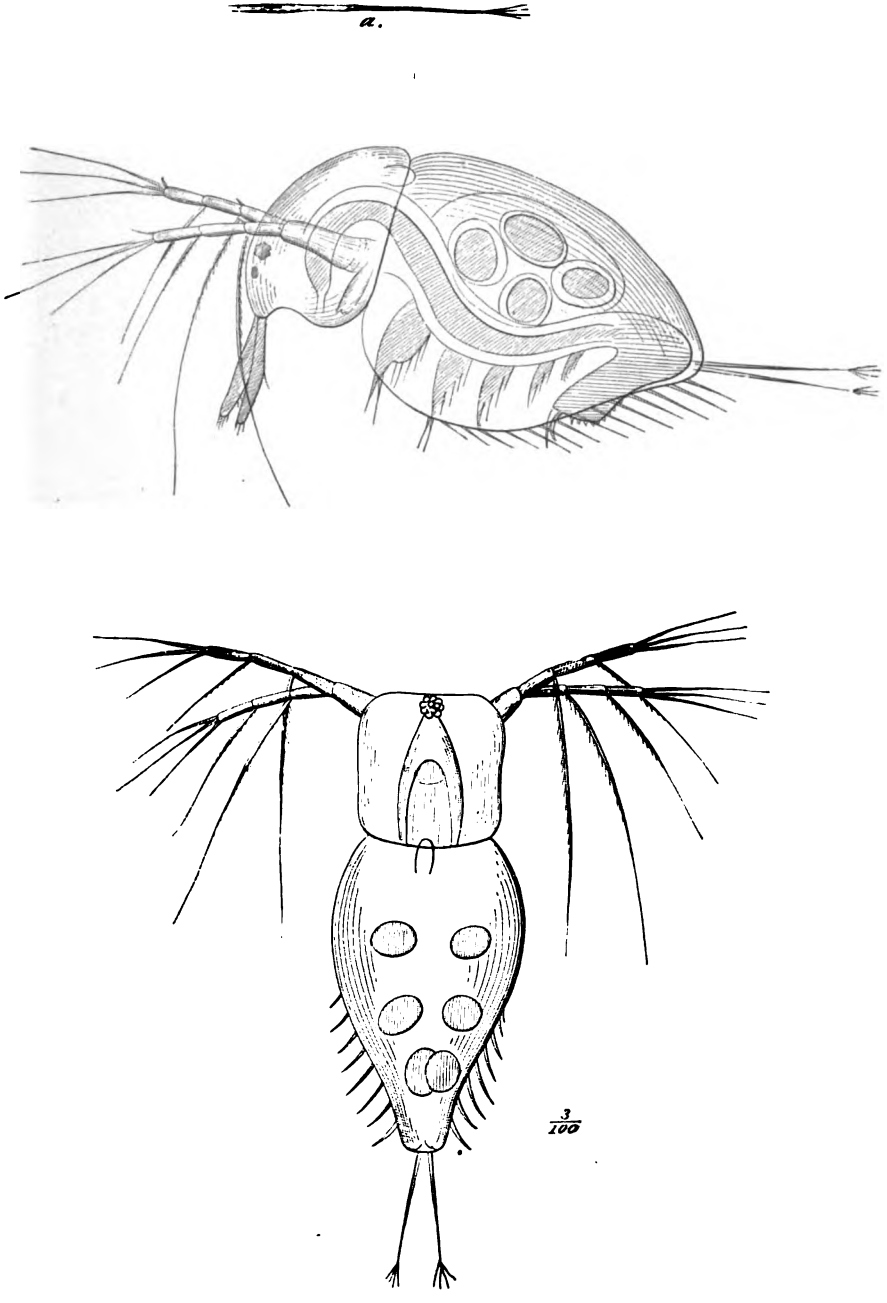

Plate XIV.

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PLATE XV.

1, ***Lynceus macrourus***, Muller. *a*, abdomen.

2, ***Lynceus quadrangularis***, Muller.
a, beak. *b*, jaws. *c*, end of antennæ.

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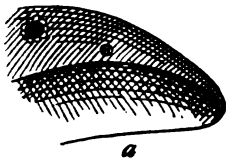

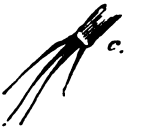

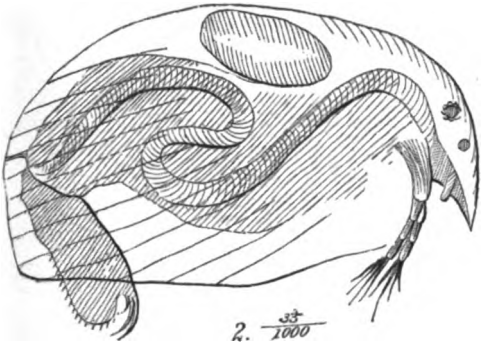

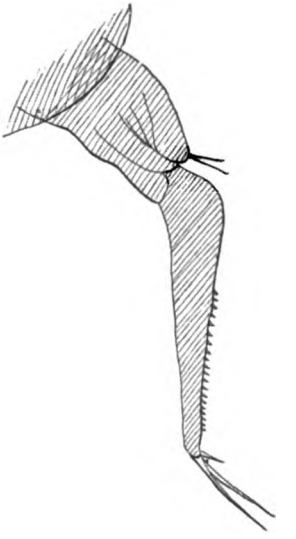

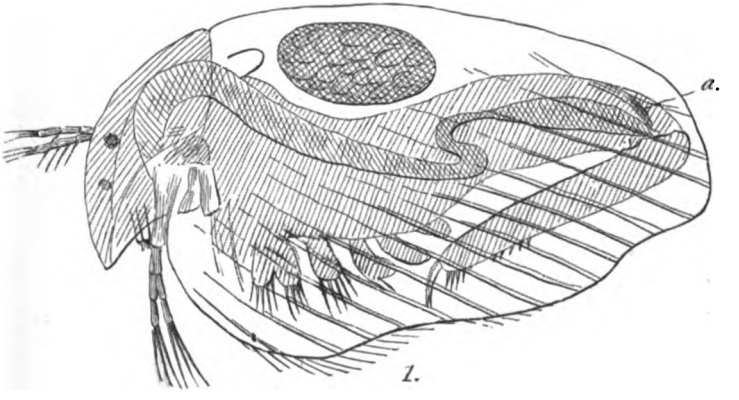

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Plate XV.

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PLATE XVI.

1, Bosmina longirostris. *a,* portion of shell, superior antennæ.

2, Lynceus sp. ?

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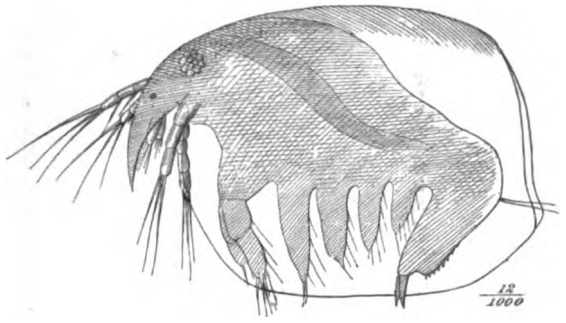

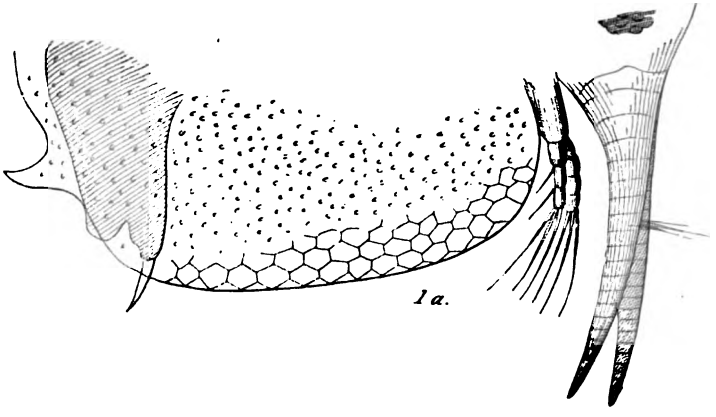

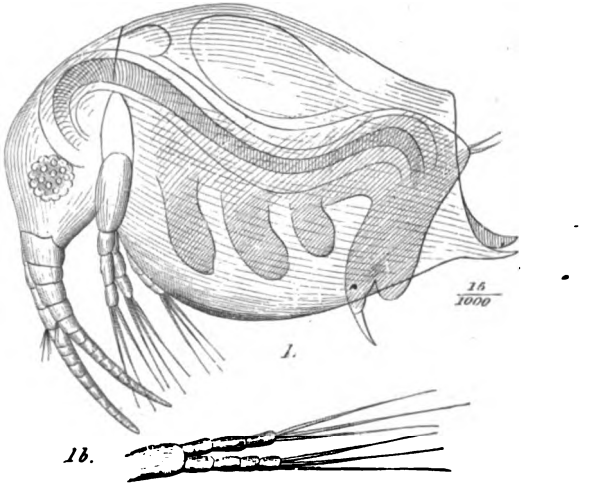

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Plate XVI.

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PLATE XVII.

1. Cypris vidua, Muller.

1′. ——— ——— top view.

2. Cypris neglecta, Herrick.

a, testicle. *b*, maxilla. *c*, caudal stylets. *d*, inferior antennæ.

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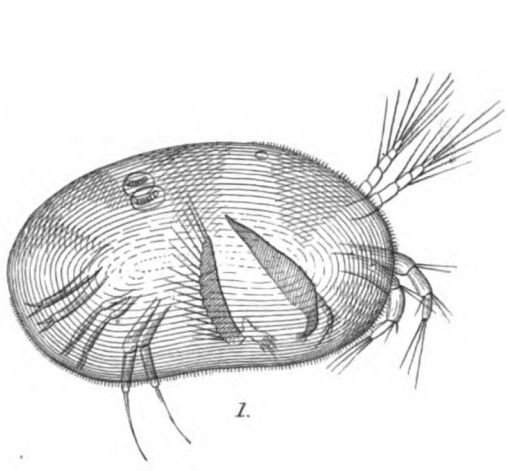

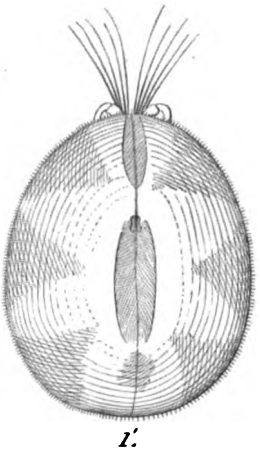

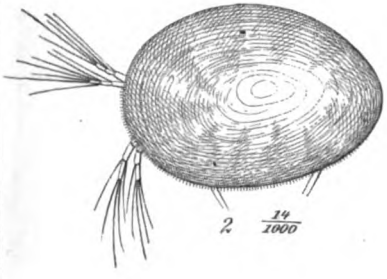

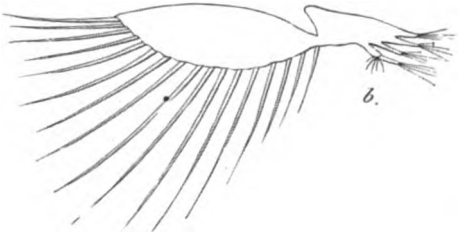

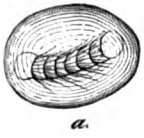

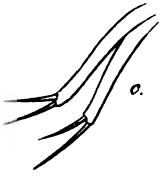

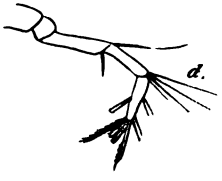

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Plate XVII.

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PLATE XVIII.

Chirocephalus diaphanus. *a*, head of female. *b*, head of male with claspers removed. *c*, head of male. *d*, appendage of claspers.

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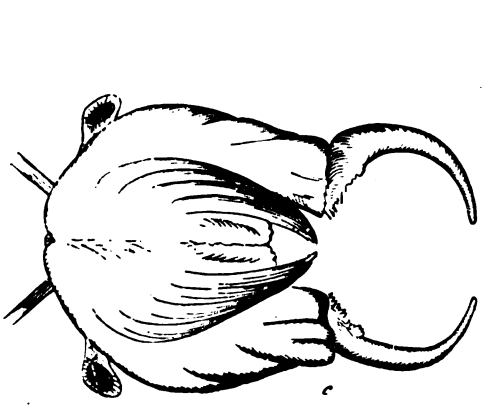

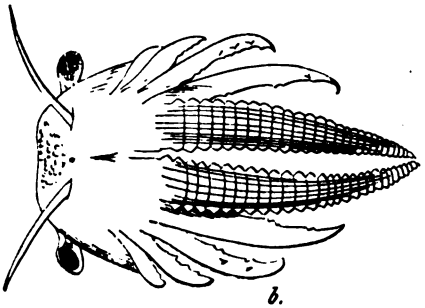

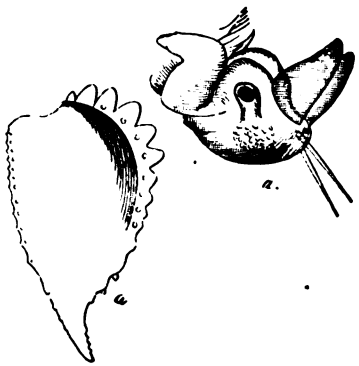

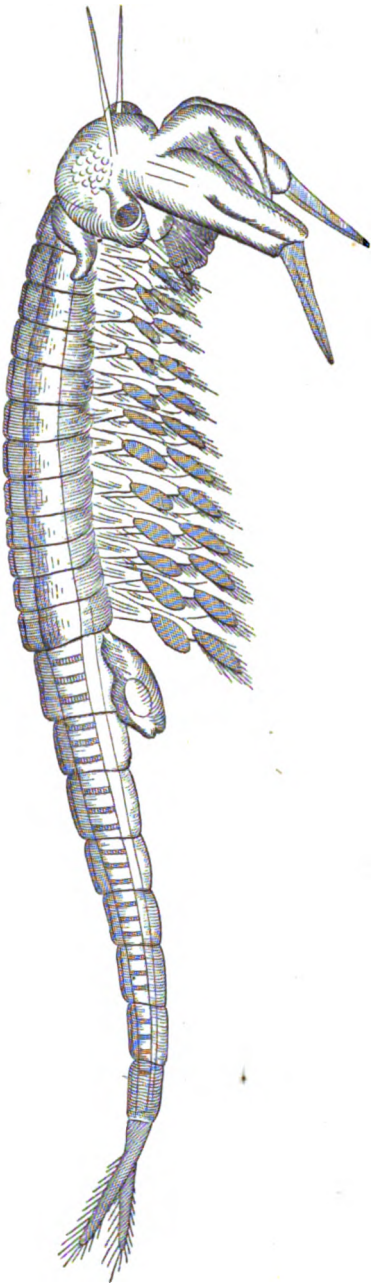

Plate XVIII.

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PLATE XIX.

Nebalia, Streptocephalus, Artemia, Apus, Estheria and Limnetes.

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The Geological and Natural History Survey of Minnesota.

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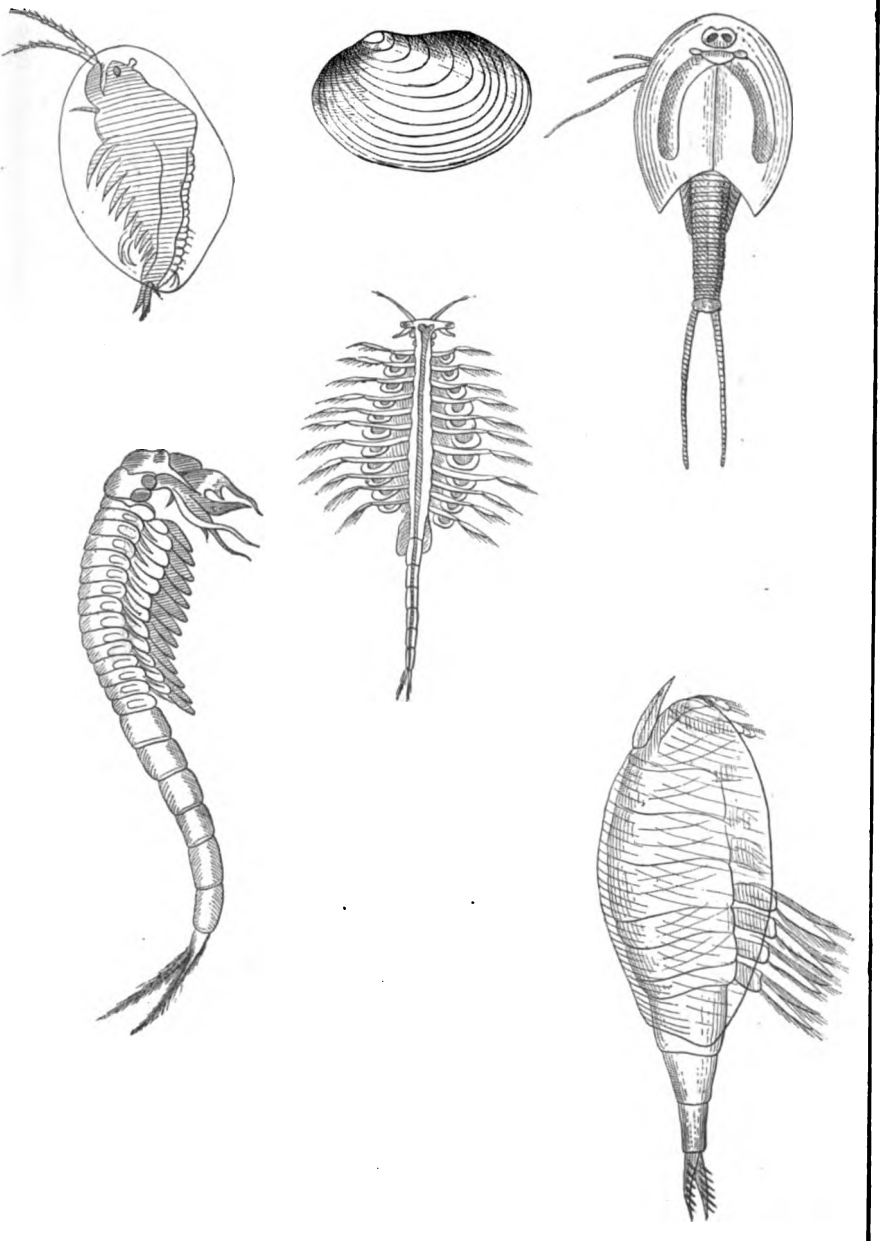

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Plate XIX.

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PLATE XX.

1. *Candona ornata*. 2. *Candona elongata*. 2*a*, testicle? 2*b*, maxillipeds.

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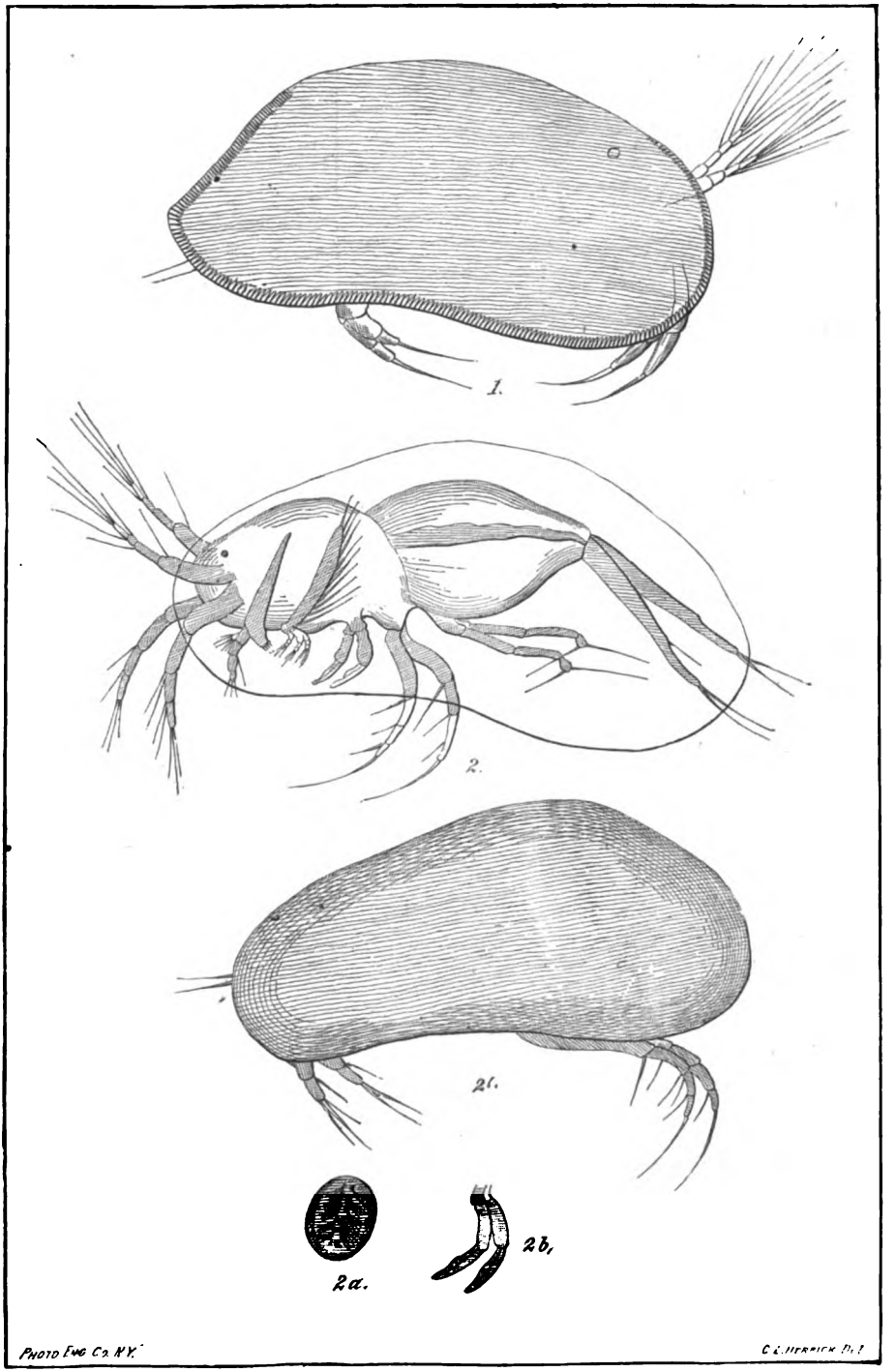

Plate XX.

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